

MOTION THE FOURTH SPATIAL DIMENSION

**Uniting Four-Dimensional Geometry and
Spacetime toward Force, Possibility and
Intelligence**

Second Edition

Stuart Hood

Preface	3
Introduction	5
1. A Dynamic Visualization	12
2. The Mathematics of Motion	37
3. Laws of Motion	52
4. Time	56
5. The Fifth Dimension: Force, A Matter Manifest	61
6. The Sixth Dimension: Possibility, Beyond Space	77
7. The Seventh Dimension: Intelligence	82
8. Epilogue: Implications of Motion as the Fourth Spatial Dimension	92
A Final Note	96

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Preface

I was deeply intrigued when the idea that this book is based on first came to me. As I began researching to see if anyone had shared a similar concept, I was surprised to find that within the vast academic worlds of physics, mathematics, philosophy and metaphysics, nothing close has ever been suggested. Even an inquiry into the realm of new age speculation produced nothing—except, quite unexpectedly, a fellow Canadian blogger who had independently proposed a comparable idea just a few months earlier.¹ Aside from his brief set of axioms and some thoughts on time and relativity, no one else appeared to be exploring the unique proposition of motion as the fourth spatial dimension.

With a new perspective to present the world, I was beyond excited, and my ideas were at first very concisely, yet very roughly, presented in essays, academic papers and personal blog posts that I felt the world needed to see immediately. I should say, I am by no means a distinguished academic; I am, however, a lifelong science and math enthusiast. I was an honour roll student throughout high school, and studied some advanced post-secondary math in college—teaching myself the basics of calculus later in life. Some of my ideological development came through documentaries such as Carl Sagan’s *Cosmos* and Brian Greene’s *Elegant Universe* which both touch on the idea of dimensions. I

¹ <https://lovinthings.com/the-4th-dimension-is-motion>

spent much of my twenties independently studying philosophy and esoterica, some of which delved into existential orders (Manly P. Hall's *The Secret Teachings of All Ages* and H. P. Blavatsky's *Isis Unveiled* and *The Secret Doctrine*) and have also worked varied jobs that use math and geometry, from computer programming, web development, graphic design and as a skilled tradesman in plumbing.

As the idea continued to develop, I found that I had much more to say; so, to explore the concept fuller and speak to a broader audience, I began drafting this book. Along the way I discovered many things that resonated very well with the core idea, and this work is the culmination of that effort. It is also an invitation to consider a bold new perspective that I believe belongs in the broader conversation around dimensionality. I believe this perspective has the capacity to end much of the debate around the fourth dimension, whether it is spatial or temporal—I believe, in fact, that it is simply both.

I encourage the reader to stay until the end of the book where I offer a personal and spiritual insight to these ideas, giving glory to God who I believe made all these things possible.

Introduction

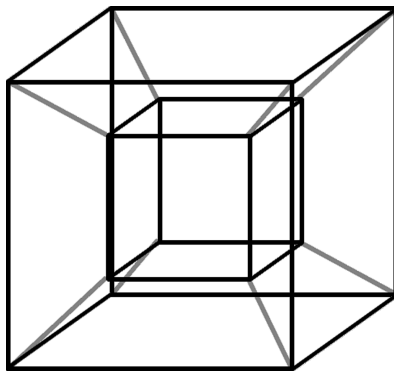
“A mind that is stretched by a new idea can never go back to its original dimensions.” —Oliver Wendell Holmes

It is here proposed that four-dimensional geometry, as exemplified by Charles Hinton’s tesseract, should not be understood to represent a fourth *static* spatial axis that is orthogonal to three-dimensional space. Instead, it should be conceived to represent three-dimensional objects as they move through a fourth spatial axis that considers both space and time—a *spacetime axis*. This represents the natural next step in the spatial progression of static three-dimensional objects: *motion*.

This proposal brings together two dominant views of the fourth dimension: the extra spatial axis of Hinton’s tesseract and the fourth dimension of time as popularized by Hermann Minkowski and Albert Einstein in the spacetime concept of relativity. By combining the two ideas, it will be seen how the already-established and mathematically-sound constructs that represent four-dimensional geometry can perfectly align with this new perspective—by being ideal representations, not of an abstract higher orthogonal axis, but simply of the spatial process of motion.

The most commonly known conceptual four-dimensional

object is the *tesseract*, or *hypercube*, popularized by Hinton in his 1888 book *A New Era of Thought*.² It is traditionally understood to be the spatially four-dimensional progression of a cube, and is usually represented by a three-dimensional analogue (or projection) as depicted below—a smaller cube nested within a larger cube, with all corners connected by new “four-dimensional edges.” Through a method called *recursive progression*, Hinton derived this geometrical construct based on the properties of its lower-dimensional forms: the cube and the square. Just as we can picture a square as two parallel lines joined by edges that run in a new perpendicular direction, and a cube as two parallel squares joined by edges that run in a new perpendicular direction, the progression of the cube into a tesseract is then thought of as two cubes connected by new edges that run in a hypothetical fourth direction.

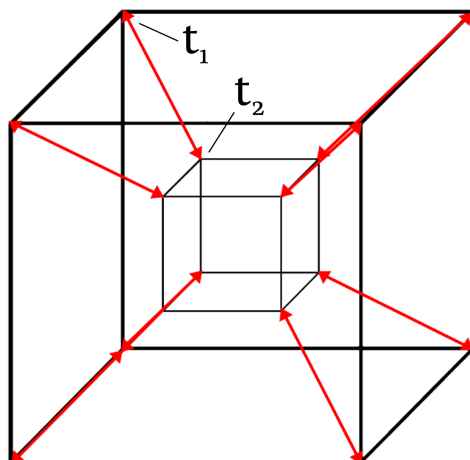


A 2D image of a 3D projection of Hinton's 4D tesseract—a cube nested within a larger cube with new “four-dimensional edges” connecting them.

² Charles Howard Hinton, *A New Era of Thought* (1888).

Since then, the conceptual tesseract and its three-dimensional projection shown here have served as the standard representation of a spatially four-dimensional object—a shape presupposing a static fourth spatial axis, an abstract direction at a new right angle to length, width, and height, demanded by recursive mathematics and logic. This book proposes, however, that no such additional static perpendicular axis exists beyond our familiar three spatial directions. The new “four-dimensional edges” of the tesseract (along with other four-dimensional polytopes) need not depict an unreachable higher space. Instead, what they can perfectly represent is what this book advances as a more complete regard of the fourth spatial dimension: the *motion* of three-dimensional objects as enabled by the non-spatial dimension of time within space (spacetime).

Through this lens of understanding, the tesseract can be seen as a representation of a cube’s progression from a basic static three-dimensional form into a spatially four-dimensional manifestation of motion—specifically, its motion of expansion or contraction. Imagine the outer cube as a cube at one moment in time and the inner cube as the *same* cube at a later moment. The “four-dimensional edges” that connect all the corresponding corners are then the *paths of motion*—represented by displacement vectors tracing each corner’s trajectory through spacetime—as the cube shrinks over time.



Here the tesseract's 3D projection can represent the motion of a single cube from one point in space and time to another, a four-dimensional geometric process that includes both space and time.

This mirrors another idea from Minkowski, formalized in 1908, called the *worldline*, which is the four-dimensional history of an object as it moves through space and time.³ The above example shows the tesseract-projection simply to represent the worldline of a cube undergoing motion of expansion or contraction. The same can be seen with other forms of four-dimensional representations, from the 4-simplex to the 3-sphere, examples of which will be shown in *Chapter 1: A Dynamic Visualization*.

Echoes of this idea can be seen well before Minkowski's

³ Hermann Minkowski, "Space and Time" (lecture delivered 21 September 1908), published in *The Principle of Relativity* (1923).

proposal, one of which is an anonymous contribution to *Nature* in 1885—suspected to be from mathematician James Joseph Sylvester—that envisioned “a new three-dimensional space for each successive instant of time,” forming a “four-dimensional solid” from an object’s successive positions.⁴ Even earlier, in 1797, Joseph-Louis Lagrange suggested in his *Théorie des fonctions analytiques* that mechanics could be regarded as “four-dimensional geometry” with time as a fourth coordinate.⁵ Chapter two, *The Mathematics of Motion*, deals with those ideas more in-depth.

Bernhard Riemann—the mathematician who most deeply influenced Charles Hinton’s late 19th century work on dimensions—delivered his groundbreaking lecture in 1854, describing dimensions as “multiply extended magnitudes” (mehrfach ausgedehnte Größen): magnitudes that can be extended once (a line), twice (a surface), threefold (a volume), and, by natural continuation, four times, five times, or more.⁶ Each new extension confers a new capacity of being—not necessarily another right-angled direction, but a new, measurable way for existence to unfold.

This book seeks to build upon Riemann’s definition of “multiply extended magnitudes,” not limiting measurable aspects to purely spatial extensions, but moving beyond, toward what is commonly

⁴ Letter signed “S.” (widely attributed to James Joseph Sylvester), *Nature* 31, no. 804 (26 March 1885): 481.

⁵ Joseph-Louis Lagrange, *Théorie des fonctions analytiques* (1797).

⁶ Bernhard Riemann, “On the Hypotheses Which Lie at the Bases of Geometry” (1854), translated by William Kingdon Clifford, *Nature* (1873).

measured within and even beyond space. This idea may be best understood by further defining dimensions as “*existential capacities*,” which are fundamental capabilities of both spatial and non-spatial existence that introduce a new level of being and measurement within the world.

Through the existence of space there exist the base three orthogonal axes (x, y, z) which are purely spatial capacities allowing for the formation of three-dimensional objects. There is then a non-spatial existential capacity for time, or duration. These foundational capacities have been joined in Minkowski’s and Einstein’s concept of spacetime—a four-dimensional continuum that denotes time as a fourth dimension. Spacetime, then, grants three-dimensional objects a new spatial capacity: *motion*. This book proposes that this capacity for motion—enabled by spacetime—is the true fourth spatial dimension, and shows how the already-established conceptions of four-dimensional geometry perfectly express it.

For more than a century, the standard explanation of the fourth spatial dimension — a new direction at right angles to length, width, and height — has left students and curious minds alike permanently puzzled, and for good reason: it describes something genuinely unvisualizable and physically unreachable. Yet the mathematics of spacetime, computer animation, robotics, and physics engines already treats the motion of 3D objects as a four-dimensional geometric process. The formal tools are in place. What has lagged behind is the story we tell about them. This book

proposes that it is time to retire the orthogonal-axis explanation in favour of one that is not only mathematically consistent, but immediately perceivable—one that finally closes the gap between the geometry we already use and the reality we already inhabit.

We do not need to discover the fourth spatial dimension.

We are already living in it, as the dynamic, ever-moving world around us.

—

With this foundation in place, the book continues by exploring how force may be understood as a fifth existential capacity, followed by possibility as a sixth, and finally intelligence as a seventh. Together they form a coherent progression from physical reality into the realm of mind and meaning.

1. A Dynamic Visualization

“The truth may be puzzling. It may take some work to grapple with. It may be counterintuitive. It may contradict deeply held prejudices... But our preferences do not determine what’s true.” —Carl Sagan,
Cosmos

In 2023, while doing a personal study on mathematics, I read through Timothy Gowers’ *Mathematics: A Very Short Introduction*, which has a chapter on exploring dimensional analysis and visualizing the fourth dimension.⁷ I had been introduced to such an exercise many years before while watching Carl Sagan’s *Cosmos* documentary in which he describes an object as a three-dimensional “shadow” of a four-dimensional hypercube, or tesseract. Most of my past attempts to understand the fourth spatial dimension seemed to fall short of a concrete apprehension, but this time around, while reading Gowers’ book, I was keen to understand the fourth spatial dimension better.

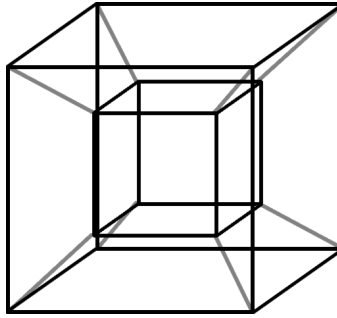
Carl Sagan’s explanation of visualizing the fourth spatial

⁷ Timothy Gowers, *Mathematics: A Very Short Introduction* (Oxford University Press, 2002), chapter on “Higher Dimensions.”

dimension is typical of most conventional attempts. Here is a transcript from the *Cosmos* documentary series:

“Now, let’s take this three-dimensional cube and project it, carry it, through a fourth physical dimension at right angles to [the three known] directions. I can’t show you what direction that is. But imagine that there is a fourth physical dimension. In that case, we would generate a four-dimensional hypercube, which is also called a tesseract. I cannot show you a tesseract because I and you are trapped in three dimensions. But what I can show you is the shadow in three dimensions of a four-dimensional hypercube or tesseract. This is it—and you can see its two nested cubes, all the vertices connected by lines. And now the real tesseract in four dimensions would have all lines of equal length and all the angles right angles. That’s not what we see here, but that’s the penalty of projection. So, you see, while we cannot imagine the world of four dimensions, we can certainly think about it perfectly well.”⁸

⁸ Carl Sagan, *Cosmos*, episode 10, “The Edge of Forever” (1980).



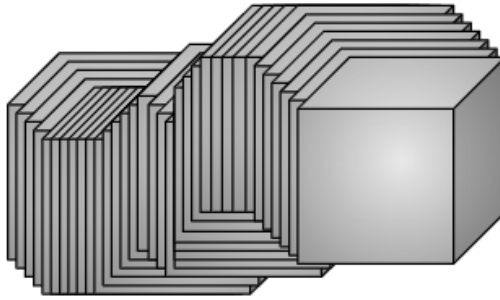
A 2D drawing of what Carl Sagan was describing as a 3D “shadow” of a 4D tesseract. A cube nested within a cube with new “4D edges” connecting the corners (vertices).

As I mentioned, I’ve struggled to grasp a fourth spatial dimension as scientific and mathematical thinkers often present it—a concept supported by mathematics but exhausting to visualize. A foundational description, as represented here by Sagan, conceives of it as a new direction mutually orthogonal (at a 90 degree right angle) to all three familiar spatial dimensions (length, width, and height). This geometric interpretation is a cornerstone of higher-dimensional geometry, the most iconic illustration of this concept being undoubtedly the tesseract, or hypercube, which was extensively explored and popularized by Charles Howard Hinton in his works such as *A New Era of Thought* (1888) and *The Fourth Dimension* (1904), where he developed methods for visualizing higher dimensions.⁹

⁹ Hinton, *A New Era of Thought* (1888) and *The Fourth Dimension* (1904).

A Personal Revelation

Inspired to tackle this in my own way, I began to examine each dimension through the recursive progression method, first by drawing a dot, then a line, a square, and a cube. As I did, I noticed that each dimension builds on the previous one, replicated into a new direction as a new type of form. A point, copied infinitely in one direction, becomes a line. A line, stretched perpendicular to itself with infinite copies in a new direction, can become a square. Similarly, a square replicated in a new direction perpendicular to its face can form a cube. How, then, could a cube extend further? I imagined, in the same way as the lower dimensions, the entire cube being replicated, not in some new direction, however, but within the already existing directions, and a visualization came to my mind as I imagined the outcome; it was like what is commonly used in illustrations to depict moving objects' motion trails. This led to a striking revelation: *motion itself* could be the next spatial dimension, with an object's motion pathways—the history of its positions and changes through space and time—as an additional geometrically-measurable part of its full form. The new direction that the cube was replicated into was not a new spatial direction, but instead a temporal direction of *duration within space—a spacetime axis*, perfectly representing the natural next existential progression of any static three-dimensional object: *motion*.

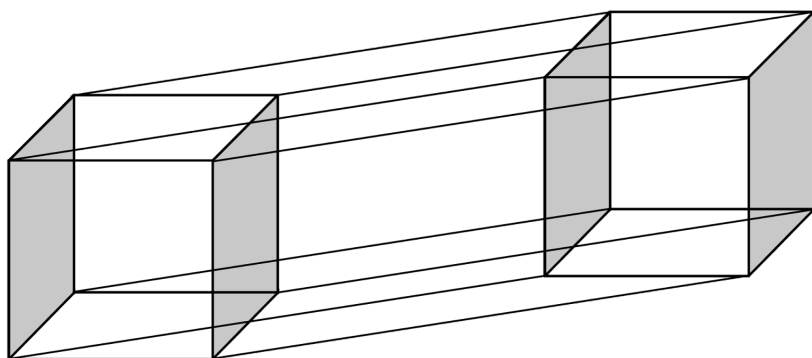


A “trail of cubes”, commonly seen in illustrations as representing a cube’s history, or pathway, of motion.

In the physics of relativity, time is considered the fourth dimension. Yet motion, which takes place *within* space, offers a better way to understand a fourth *spatial* dimension that *includes* time. Motion is the manifestation of what 3D space paired with the fourth dimension of time enables, and the history of an object’s change through both space and time (what Minkowski called a “worldline”) forms a *new measurable extent*, the very definition of what a dimension is. Motion is therefore the next natural *spatial* dimension beyond static 3D forms, a dimension that includes the non-spatial dimension of time as a necessary metric for measuring it.

Gowers in his book goes on to describe a different 4D representation of a cube:

“I can think of a four-dimensional cube as consisting of two three-dimensional cubes facing each other, with corresponding vertices joined by edges (in the fourth dimension), just as a three-dimensional cube consists of two squares facing each other with corresponding vertices joined. Although I do not have a completely clear picture of four-dimensional space, I can still ‘see’ that there are twelve edges for each of the two three-dimensional cubes, and eight edges linking their vertices together.”¹⁰

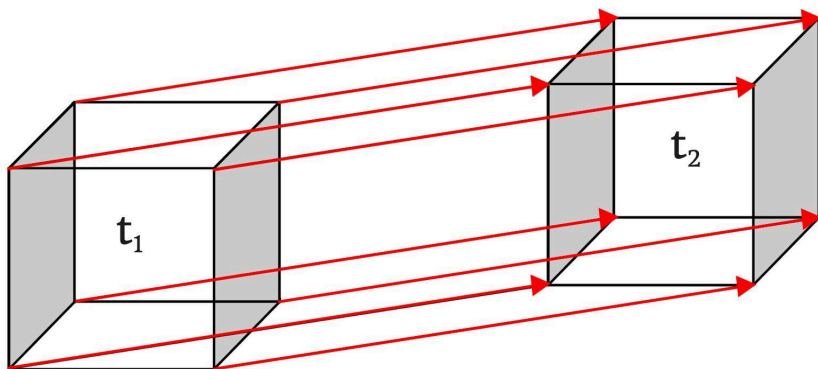


Another common depiction, as how Gowers describes, of a four-dimensional cube.

Through this book’s idea of the new “4D edges” representing motion’s spatial pathways, this sort of visualization can simply describe a cube’s pathway of positional motion. As with the reinterpretation of the tesseract earlier, the two cubes can represent a single cube’s starting point

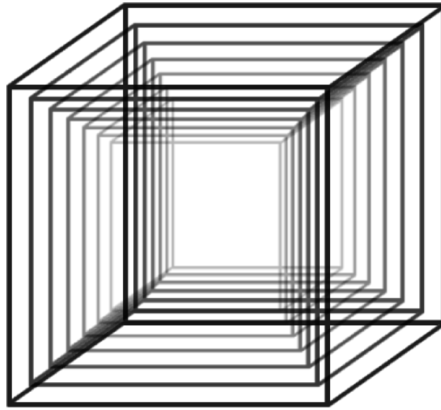
¹⁰ Gowers, *Mathematics: A Very Short Introduction*.

and ending point, while the connecting lines represent its pathway, or history, of motion, represented by displacement vectors.



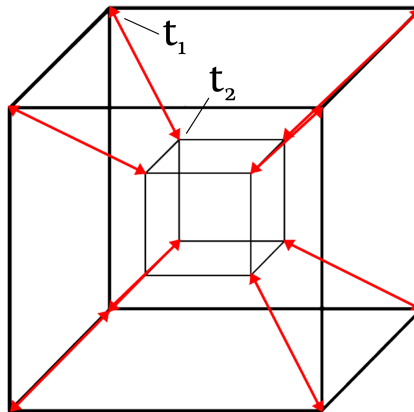
Another common representation of a four-dimensional cube, this version of a hypercube can perfectly represent a cube's positional motion from one point to another.

Consider again a different type of a cube's motion, of it expanding or contracting; what shape does the trail of its changing size make? It draws exactly what Carl Sagan showed to be a three-dimensional representation, or "shadow", of a four-dimensional tesseract.



The tesseract's 3D "shadow" can be a visual representation of a cube's motion pathways of expansion or contraction.

When the motion pathways of an object are treated as a part of its spatial 4D nature, the tesseract's 3D "shadow" certainly does become a representation of a 4D progression of a cube—specifically, the 4D geometric trace of a cube expanding or contracting through space over time.



The entire path of an object's movement—its shifting form or position over time—can be conceived as a continuous 4D structure like Mikowski's worldline. In this view, any fourth dimensional spatial history of an object's motion can be three-dimensionally represented by the geometric form traced by its motion through time.¹¹

Carl Sagan said, "I cannot show you a tesseract because I and you are trapped in three dimensions."¹² I hold the deepest admiration for Sagan and his work, but through the process of developing the idea of this book, I've come to believe otherwise. We are not trapped in three dimensions. When we conceive of the fourth spatial dimension as simply the capacity for motion, we realize that the moving world around us is the true expression of that fourth dimension.

Revisiting Flatland

Edwin Abbott's *Flatland: A Romance of Many Dimensions* (1884) remains the most famous analogy for understanding a fourth spatial dimension.¹³ As it describes, when a 3D sphere passes through a purely 2D world, the flatlanders who live in that world see only a circle that first

¹¹ It may be that an object's history of motion since the beginning of time constitutes its entire fourth-dimensional nature, but this work will focus on segmented moments of time.

¹² Sagan, *Cosmos* (1980).

¹³ Edwin A. Abbott, *Flatland: A Romance of Many Dimensions* (1884).

appears as a small dot, grows, and then finally shrinks and vanishes—a changing 2D slice of a fixed higher-spatial object.

Through this mental exercise, Abbott suggested how we may understand in the same way how a spatially 4D object might appear to us as it passed through our 3D world. This has intrigued thinkers ever since, and many look to Hinton's tesseract-projection as an example of how a 4D progression of a cube appears in our limited 3D perception.

The analogy is rightly celebrated, yet it grants the flatlanders something that must be withheld for the sake of this book's argument: the dimension of time itself. In the original analogy, the lower-dimensional objects have capacity for motion, which is what this book is proposing to be part of the fourth dimension. With that in mind, the original analogy can still work if we just consider each scenario within one snapshot of time, i.e. at one instant in time, a sphere will still appear as a circle in a 2D world. So, to complete Abbott's thought experiment with that in mind, imagine a more accurate scenario of purely 3D beings who lack the capacity for time and motion—static-landers. To them, a 4D (moving) cube would appear not as the static 3D tesseract-projection many may have anticipated, but only as a single cube frozen in time—its full experience of motion accessible only to higher, 4D beings who can experience motion.

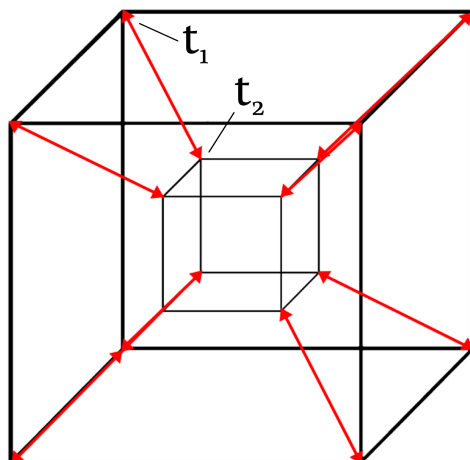
Yet those 4D beings could just as well present the familiar tesseract-projection (the nested cubes joined by new edges) to the 3D static-landers as a perfect representation of their own higher dimension: a

static, three-dimensional time-map of a cube's motion in contraction or expansion.

A New Coordinate System?

One of the earliest questions raised by the idea of motion as the fourth spatial dimension was how to express it within a coordinate system. Since time and motion are inherently linked—time is measured by motion, and motion by time (see *Chapter 4: Time*)—we retain the temporal axis, t , as the metric for tracing spatial transformation. That fourth component in the (x, y, z, t) framework is integral to recording an object's motion history over successive intervals.

Take the expanding or contracting motion of a cube, which mirrors the projection of a tesseract. Its eight vertices at t_1 have coordinates from (x_1, y_1, z_1, t_1) to (x_8, y_8, z_8, t_1) . At t_2 , after transformation, these shift accordingly. Plotting the change on a 3D graph, we can draw new lines between the t_1 sets and the t_2 sets, tracing the cube's transformation. These new paths—what have been considered “4D edges”—can be represented as displacement vectors, whose magnitudes (inferred from the spatial distance traveled over $\Delta t = t_2 - t_1$), quantify the motion's extent as a measurable, existential capacity.



The outer cube's corners are marked t_1 , while the inner cube mirrors these corners at t_2 . The red lines between them represent each corner's motion over time as displacement vectors.

In the world we live in, a cube moving through space leaves no visible trail—but conceptually, its history forms a shape. For basic motions, this might be a single path represented by a line or curve, but for more complex changes—like morphing into another shape—the representation of that motion might become a 3D web-like volume, requiring more intricate ways to fully describe an object's paths of change.

A Time-Space before Spacetime

Well before Minkowski's 1908 idea of spacetime, and around the same time Hinton was developing the tesseract, an anonymous letter was published in the science magazine *Nature* in 1885 under the name "S." It is widely attributed to James Joseph Sylvester, a prominent 19th-century English mathematician, co-founder of invariant theory and a pioneer in matrix theory, whose influence extended across algebra, geometry, and number theory. The letter proposes time as a fourth dimension, mentioning the need for a 'time-space' to account for it:

"POSSIBLY the question, What is the fourth dimension? may admit of an indefinite number of answers. I prefer, therefore, in proposing to consider Time as a fourth dimension of our existence, to speak of it as *a* fourth dimension rather than *the* fourth dimension. Since this fourth dimension cannot be introduced into space, as commonly understood, we require a new kind of space for its existence, which we may call time-space. There is then no difficulty in conceiving the analogues in this new kind of space, of the things in ordinary space which are known as lines, areas, and solids. A straight line, by moving in any direction not in its own length, generates an area; if this area moves in any direction not in its own plane it generates a solid; but if this solid moves in any direction, it still generates a solid, and nothing more. The reason of this is that we have not

supposed it to move in the fourth dimension. If the straight line moves in its own direction, it describes only a straight line; if the area moves in its own plane, it describes only an area; in each case, motion in the dimensions in which the thing exists, gives us only a thing of the same dimensions; and, in order to get a thing of higher dimensions, we must have motion in a new dimension. But, as the idea of motion is only applicable in space of three dimensions, we must replace it by another which is applicable in our fourth dimension of time. Such an idea is that of successive existence. We must, therefore, conceive that there is a new three-dimensional space for each successive instant of time; and, by picturing to ourselves the aggregate formed by the successive positions in time-space of a given solid during a given time, we shall get the idea of a four-dimensional solid, which may be called a sur-solid. It will assist us to get a clearer idea, if we consider a solid which is in a constant state of change, both of magnitude and position; and an example of a solid which satisfies this condition sufficiently well, is afforded by the body of each of us. Let any man picture to himself the aggregate of his own bodily forms from birth to the present time, and he will have a clear idea of a sur-solid in time-space.”¹⁴

Remarkable. Years before Minkowski’s spacetime, an anonymous contributor coined a “time-space” to account for

¹⁴ *Nature* 31, no. 804 (26 March 1885): 481.

four-dimensional comprehension. Here the writer does acknowledge motion, asserting that “the idea of motion is only applicable in space of three dimensions.”¹⁵ Yes, motion does take place within 3D space, but it is a further extended spatial manifestation of objects in that space—one that the dimension of time enables. So, a more accurate statement would be that motion only takes place within 4D spacetime.

Also, as with the flatland analogy described earlier, the writer begins to describe motion *within* the lower dimensions, even after proposing time as the 4th dimension—a mistake that I think shows they do not yet recognize motion as a part of 4D geometry exclusively. Interestingly, what the writer does prefer to focus on is an unmoving object “moving” only through time and not space, which indeed can also be represented by a hypercube (see below).

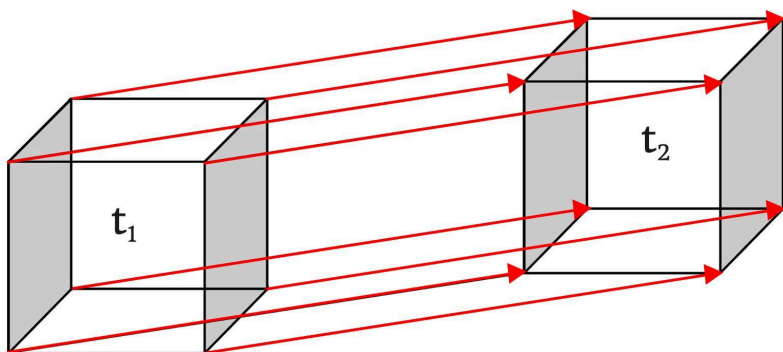
“Let us now consider the sur-solid formed by the movement, or rather, the successive existence, of a cube in time-space. We are to conceive of the cube, and the whole of the three-dimensional space in which it is situated, as floating away in time-space for a given time; the cube will then have an initial and a final position, and these will be the end boundaries of the sur-solid. It will therefore have sixteen points, namely, the eight points belonging to the initial cube, and the eight belonging to the final cube. The

¹⁵ The assertion that it is only applicable to 3D geometry is interesting. Do 2D and 1D objects move? In the world we live in, all physical things are 3D. 2D and 1D are simply conceptual ideas. Yet what about a shadow moving across a flat area? Technically, even a shadow is a 3D field (light interacting with surfaces).

successive positions (in time-space) of each of the eight points of the cube, will form what may be called a time-line; and adding to these the twenty-four edges of the initial and final cubes, we see that the sur-solid has thirty-two lines. The successive positions (in time-space) of each of the twelve edges of the cube, will form what may be called a time area; and, adding these to the twelve faces of the initial and final cubes, we see that the sur-solid has twenty-four areas. Lastly, the successive positions (in time-space) of each of the six faces of the cube, will form what may be called a time-solid; and, adding these to the initial and final cubes, we see that the sur-solid is bounded by eight solids. These results agree with the statements in your article. But it is not permissible to speak of the sur-solid as resting in “space,” we must rather say that the section of it by any time is a cube resting (or moving) in “space.”¹⁶

Again, the last sentence addresses motion, but it seems to be only about the movement through time of a stationary object. In this scenario, the 4D edges of the hypercube, or “the successive positions (in time-space) of each of the eight points of the cube” are then simply *time lines* instead of displacement vectors—lines of direction and length that only indicate temporal intervals of duration and not spatial directions of change.

¹⁶ Ibid., 481.



"This hypercube can either represent an unmoving cube passing only through time (connected by timelines), or a moving cube passing through both space and time (connected by displacement vectors).

This all works perfectly well in this simplistic scenario, but not with the tesseract represented as a smaller cube nested within a larger one. With each cube marking an initial and end state, the size difference indicates something crucial: *spatial change* has occurred—the cube has undergone motion between states. When spatial changes happen, we need all spatial directions to represent it within a hypersolid. Using timelines, which consume a spatial direction to indicate the non-spatial “direction” of time, becomes unreliable. The possible next step in the timeline system would be warping or distorting the 4D edges to represent the motion of the object as it passes through time, but if a directional line is used to represent time, motion along that direction cannot be accurately represented. This is why a *spacetime axis*—representing change through both space and time—is the best option for 4D geometry: the

new edges become displacement vectors indicating both direction and distance, not mere timelines indicating duration. To determine duration, we simply observe the initial and end values of the t states, then pair that with the length of the displacement vector to measure the velocity of the motion.

When motion is considered here, the very act of picturing “the aggregate formed by the successive positions in time-space of a given solid,” giving us “the idea of a four-dimensional solid,” can perfectly describe the motion of a 3D form as a 4D solid. This is animation—the time-enabled 4D spatial capacity of 3D objects that is just beyond their static forms. This is a much more ideal use of 4D geometry: representing *motion*.

Acknowledging Limitations

As we step into new dimensions, our method of representing those dimensions through projections should evolve too. Through a bit of illusion, we commonly represent 3D objects on 2D paper, but limitations under certain circumstances have led to orthographic projections: front, profile, and top views for fuller understanding of 3D objects and scenes represented in 2D. With the fourth dimension, we keep all three spatial axes and add one of time. The 3D tesseract-projection cleverly represents the spatial motion of a cube expanding or contracting, but it does not show the velocity of that motion. However, notating each cube with its

corresponding t-position or the magnitudes of velocity-vectors does provide an indication.

The next challenge is representing not just velocity, but acceleration. In my system, a new cubic state would be needed for every change in velocity; steadily changing velocity might resemble the "trail of cubes" image from earlier. Alternatively, we can use connecting lines as velocity-vectors for steady motion or acceleration-vectors for steady velocity changes. Finally, how do we represent an object with constantly changing acceleration and direction? The best way may be shifting from paper drawings or static 3D models to animated 3D graphics and holography—more accurate systems for capturing more complex motion traces.

From Symmetry to Simplicity

Continuing with another of Carl Sagan's statements, he went on to explain, "the real tesseract in four dimensions would have all lines of equal length and all the angles right angles."¹⁷ Imagining our example, and with a bit of a stretch in reasoning, that indeed may be possible, as all the lengths and angles of the tesseract (a cube in contraction/expansion motion as this book explains it) stay the same relative to itself in each moment of time as it changes size. The new 4D edges formed, though, are not the same length and at the same angle; they are the

¹⁷ Sagan, *Cosmos* (1980).

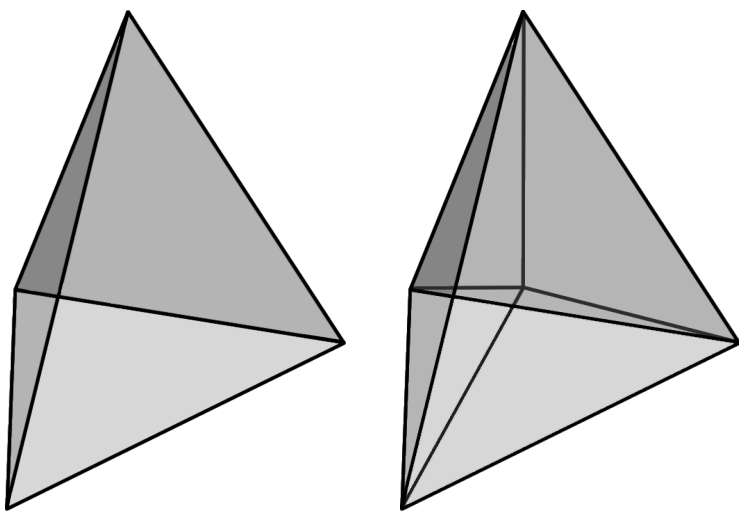
representations of the trace of the cube's motion from its corners.

Can the properties of Sagan's tesseract with the added edges at right angle be shown through a different form of motion, though? What movements must a cube make to trace out all of its displacement-vector edges at equal length while also being at right angles? That situation is not possible within one moment in time, but if the cube is moved to the many positions that will let it meet those parameters over time, then we can frame that 4D imprint as satisfying those conditions as part of its fuller geometry of motion.

This stretch in logic, however, raises an important consideration when reflecting on the standard representations of the progressions of spatial dimensions, which typically begins with a line, a square, and a cube. These are not the simplest shapes for expressing dimensional progression—they may appear so because of their *symmetry* which helps visualizing the dimensional progression. Sagan was simply continuing that symmetrical pattern from the cube to the tesseract, completing the logic of recursive progression, which is very helpful, but not always necessary when we step into higher dimensions. What, then, qualifies as truly simple?

To move from a line into another dimension, we don't necessarily need to extend it into a full square; we might simply stretch it into a thin rectangle, or draw out a single perpendicular line segment, or even stretch one point away to create a triangle. Then, from the triangle, a new 3D shape can form by pulling up another point from its face: the

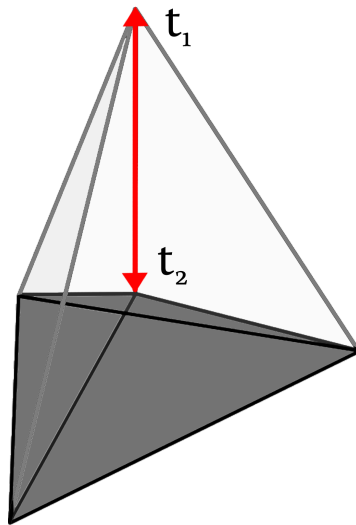
tetrahedron, and from there a tetrahedron can be made into what is known as a projection of a pentatope, 5-cell or 4-simplex, its 4D counterpart. A 4D hypercube's 3D projection is composed of a cube within a cube, but a pentatope's 3D projection is a tetrahedron with new "4D edges" from each corner meeting inside at the center, splitting the interior into three separate tetrahedra.



A tetrahedron, the simplest 3D polygon, and its 4D progression, the pentatope. Its 3D projection is here represented as a tetrahedron with "4D edges" drawn from each corner to the center.

While a 4D hypercube extends a 3D cube's pattern of increasing *symmetry* (in this book's example, a uniform motion of expansion or contraction), a 4D pentatope can be seen to continue a 3D tetrahedron's pattern of *simplicity*—both 4D shapes aligning naturally with the concept of motion as a fourth spatial dimension beyond static 3D form.

Instead of the symmetrical, uniform motion that a hypercube has been shown to exhibit, imagine just one corner of a tetrahedron moving inward toward its center. As this point shifts, its connected edges and faces deform accordingly, while the opposite face remains unchanged. The result is a progressively flattened tetrahedron (see below). The spatial history of the motion can be represented by the pentatope's 3D projection, with the imprint of the moving interior edge represented as a displacement-vector, tracing the path of change. In this sense, the 4D pentatope can be represented by a 3D map of motion made by its base shape (the tetrahedron) in the same way a 4D tesseract's 3D projection is a 3D map of a cube's uniform growth (see *Revisiting Flatland*).



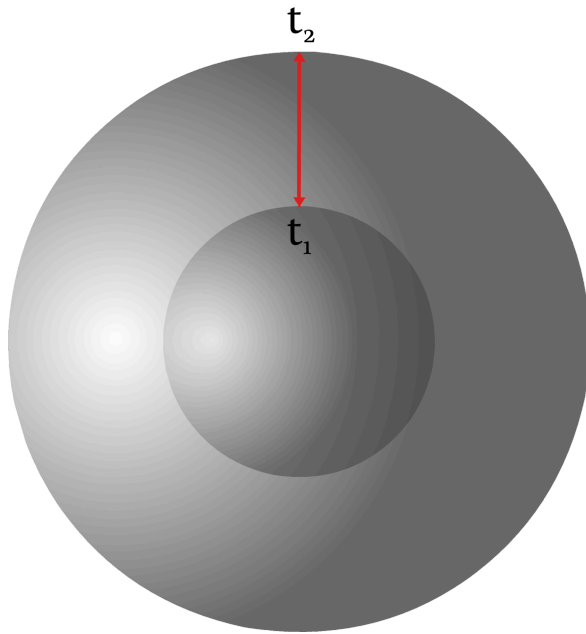
Like the hypercube, the 4-simplex's 3D projection can be a representation of the form of a motion of its base shape.

From Corners to Curves

Let's now consider a 3-sphere—the conceptual higher-dimensional progression of a regular 3D sphere—through the idea of motion as the fourth spatial dimension. A 3-sphere can be understood as the surface of a hypothetical four-dimensional sphere. While it is difficult to visualize directly (much like the tesseract), it is rigorously defined as the set of all points in four-dimensional space that lie at a fixed distance from a central origin. This mirrors how a circle (a 1-sphere) exists in 2D and a regular sphere (a 2-sphere) exists in 3D.

Unlike a cube, which gains new edges when extended into a tesseract, a sphere has no edges to “sprout” when it moves or transforms. Its boundary remains smooth and uniform in every direction, leaving no obvious structure to indicate its movement. So how do we describe its motion of expansion or contraction in terms of 4D geometry?

One approach is to consider the 3D solids swept out by that motion. Just as a cube expanding through space forms a higher-dimensional cube (a tesseract), a sphere expanding from radius r_1 to r_2 carves out a thickened region that includes the original sphere, the expanded sphere, and the new shell in between — a region bounded by two concentric 3-spheres. This creates a precise volumetric “path” of transformation through the fourth dimension, perfectly consistent with how a 4D sphere is mathematically described.



A 4D sphere's 3D projection is shown here as a smaller sphere within a larger sphere. There are no “new edges,” but a displacement vector can be attached to represent its motion of expansion or contraction.

When considering rotational motion, a sphere may appear unchanged in the static 3D snapshots over time—yet over time, each point on its surface traces a unique path through space and time. These paths, along with the form of the sphere, collectively form a higher-dimensional structure. To describe how the sphere's orientation evolves, we must attach a directional reference to it which tracks the rotational behavior as

the sphere moves, as in the case of Hopf fibers and fiber bundles.¹⁸ This entire system—the movement of points and the shift in orientation—can be understood as a transformation through 4D geometry.

¹⁸ Hopf fibers and fiber bundles are mathematical structures used in topology and geometry to describe how directional properties (such as orientation or rotation) can vary smoothly and consistently across a higher-dimensional space.

2. The Mathematics of Motion

“Geometry is the archetype of the beauty of the world.” —Johannes

Kepler

When I started developing my idea of motion as the fourth spatial dimension, I thought it would be best to ground it in real-world examples. If the mathematics of modern technologies already relies on 4D geometry to handle the motion of 3D objects, then surely that would drive home the point. Indeed, in many places I looked—from 3D holography to drone show formations, to personal VR systems—I found that programming the motion of 3D objects depends heavily on a framework of 4D geometry. Some of these technological fields are relatively new, and perhaps it is precisely because of their recent development that the shift to regarding the motion of 3D objects as true 4D geometry might become more apparent, instead of chasing a mysterious new static axis beyond length, width, and height.

As I searched, I began to collect examples that all pointed to the same structure: the movement of 3D objects necessitates a 4D (x,y,z,t) coordinate system. At first, I wondered if this only proved the conventional view—that motion is just an effect or process of the fourth dimension of time. Did this really support my main theory, that motion

itself should be understood as the definition of the fourth spatial dimension? I concluded that the real supporting evidence is that this 4D system is the *ideal* way to represent the motion of 3D objects, and that the mathematics of these systems treats motion as a 4D geometry when viewed as a collective whole rather than just collections of coordinates within one moment of time. This relates to the continued replication of dimensional progression. As a line is continuously replicated in a new direction to form a square, and so on, a cube is continuously replicated across a new axis of spacetime, manifesting a new existential capacity—the fourth spatial capacity for motion.

Now if a cube just sits dormant in spacetime, there is really no need for a 4D geometry. An unmoving cube will not protrude a four-dimensional spatial extension; it will simply remain a 3D object as time marches on. Yet it is still embedded in four-dimensional spacetime, with its fourth dimension added simply as its temporal position in time. When it does start to make spatial changes, however—manifesting motion as it moves through time and space—that is when a true 4D geometry system (like the tesseract with displacement vectors as the new 4D edges) comes into play. As soon as motion (spatial change) begins, its higher 4D spatial properties can be examined through the geometric paths of its motion.

Time is a 4D measure, but when paired with differing points in space across multiple instances, tracking spatial changes across a timeline,

it culminates in describing only one thing: the motion of 3D forms.

The Beginnings of Four Coordinates

The notion of time as a fourth dimension has roots as far back as 1754, when Jean le Rond d'Alembert speculated on the idea in his entry "Dimension" for the *Encyclopédie*:

"A clever acquaintance of mine believes that one might nevertheless consider duration as a fourth dimension, and that the product of time by solidity would in some manner be a product of four dimensions; this idea may be contested, but it has, it seems to me, some merit, if only because of its novelty."¹⁹

Joseph-Louis Lagrange suggested in 1797, in *Théorie des fonctions analytiques*, in viewing mechanics as a "geometry of four dimensions" with time as the fourth coordinate:

"The position of a point in space depends on three rectangular coordinates x, y, z ; these coordinates, in problems of mechanics, will be assumed to be functions of t . Thus, one can regard mechanics as a geometry of four dimensions, and mechanical analysis as an extension of ordinary geometry of three dimensions. The equations of motion of a system of bodies are nothing else than the differential equations which determine the

¹⁹ Jean le Rond d'Alembert, "Dimension," *Encyclopédie* (1754).

coordinates of each body as a function of time; and as these coordinates are three in number for each body, the motion of any system is determined by a number of differential equations equal to three times the number of bodies.”²⁰

Lagrange’s main body of work was an effort to shift from Isaac Newton’s geometric drawings and intuitive forces to a more mathematically pure, equation-based approach. In his book *Mécanique Analytique* (1788), he reformulated classical mechanics—the study of how objects move under forces like gravity or friction—into a unified system called analytical mechanics. Instead of relying on diagrams, he used mathematical functions and principles to describe some of nature’s most “efficient” paths of motion that an object could take, leading to predictable equations for everything from swinging pendulums to orbiting planets.

In *Théorie des fonctions analytiques* (1797), where he proposed treating mechanics as a “geometry of four dimensions,” he envisioned the three familiar spatial directions (length, width, height) extended by time

²⁰ Joseph-Louis Lagrange, *Théorie des fonctions analytiques* (1797).

Original French: “La position d’un point dans l’espace dépend de trois coordonnées rectangulaires x, y, z ; ces coordonnées, dans les problèmes de mécanique, seront censées être des fonctions de t . Ainsi, on peut regarder la mécanique comme une géométrie à quatre dimensions, et l’analyse mécanique comme une extension de l’analyse géométrique. Les équations du mouvement d’un système de corps ne sont autre chose que les équations différentielles qui déterminent les coordonnées de chaque corps en fonction du temps; et comme ces coordonnées sont au nombre de trois pour chaque corps, le mouvement d’un système quelconque est déterminé par un nombre d’équations différentielles égal au triple du nombre des corps.”

as a fourth coordinate, allowing the "history" of an object's motion—its path through space over time—to be analyzed geometrically, like plotting points on a graph. By solving for these paths through differential equations (simple rules for how positions change over time), Lagrange showed how motion could be quantified geometrically, foreshadowing modern concepts like worldlines in relativity.

Later, in 1827, August Ferdinand Möbius introduced what is known as the homogeneous coordinates system—first systematically used in his work *Der barycentrische Calcul*—specifically to address change (motion) within 3D space.²¹ It was developed for use in projective geometry to work with static 3D scenes, but the idea of motion still applies with the changing perspectives on that scene. The homogeneous system was what would become the backbone of modern programming of animated 3D objects, some of which the next section will go into detail on.

Mathematics of Motion in Modern Technology

The following are some examples of how modern systems use 4D geometry to program the motion of 3D objects. I will leave it to the reader to decide whether these examples constitute ample proof of motion's place as the true definition of the fourth spatial dimension, or whether they simply reinforce the conventional view of time as the fourth

²¹ August Ferdinand Möbius, *Der barycentrische Calcul* (1827).

dimension with motion as its spatial effect.

As time and motion are intrinsically linked (see *Chapter 4: Time*), I believe these examples may actually reinforce both ideas at once. While time is indeed a fourth dimension in its own right, it is also an integral part of a fuller fourth *spatial* dimension—one that *motion* is the prime manifestation of.

In 3D computer graphic animation, objects are first built mathematically in three-dimensional space using (x, y, z) coordinates. However, to display change or motion on screen, a fourth coordinate—time (t)—must be introduced. This transforms the animation from a series of static 3D frames into a continuous 4D process.

A prime example is spacetime constraints, pioneered by Andrew Witkin and Michael Kass in their 1988 SIGGRAPH paper "Spacetime Constraints."²² This technique optimizes complex animations by treating the entire motion sequence as a single path in 4D spacetime, rather than isolated frames. In practice, animators define high-level goals or "constraints"—such as a character leaping from point A to B while dodging obstacles or minimizing energy use—and the system solves for the most efficient trajectory across time. Mathematically, this involves formulating the character's state as a function in (x, y, z, t), where time (t)

²² Andrew Witkin and Michael Kass, "Spacetime Constraints," *SIGGRAPH Computer Graphics* 22, no. 4 (1988): 159–168.

is the parameter along a 4D curve (worldline). The optimization uses variational methods (echoing Lagrange's calculus of variations) to minimize an "action" integral over the path, ensuring smooth, physically plausible motion.

For instance, in a jumping animation, the system computes the full arc—initial velocity, mid-air adjustments, and landing—as a geodesic-like curve in a 4D manifold (i.e. the most efficient possible path on a curved surface), factoring in gravity, momentum, and constraints like "avoid this sphere at $t=2$." This global approach unifies the sequence into a holistic geometric entity, much like this book's reinterpretation of the tesseract as a motion history; discrete 3D "slices" (frames) accumulate into a continuous 4D solid. As Witkin and Kass note in their paper, "Our results show that spacetime methods are capable of producing realistic, complex and coordinated motion given only minimal kinematic constraints." This bridges abstract geometry with practical effects, aligning with this book's view that 4D polytopes like the tesseract represent motion's "capacity" beyond static axes.

Other techniques similarly leverage 4D geometry. Keyframe interpolation with Bézier splines calculates smooth curves between "key" positions in (x, y, z, t) space, extruding 3D meshes over time to create lifelike arcs—treating motion as a geometric extrusion in higher dimensions, as in Blender or Maya software. This method allows animators to define start and end states, with the algorithm filling in intermediate frames by parameterizing t along a 4D spline, ensuring

seamless transitions that reflect motion's continuous spatial nature rather than disjointed steps. By modeling the entire animation as a single higher-dimensional path, it underscores how time enables the "replication" of 3D forms into a unified 4D entity.

Physics engines, like Unity's PhysX or Unreal Engine, simulate real-world motion by integrating forces over time in 4D trajectories: objects' paths are worldlines in spacetime, with t enabling spatial changes like collisions, directly quantifying motion as a spatial entity in games or VR.²³ These engines solve differential equations (echoing Lagrange's methods) to predict future states, treating time as an integral coordinate that unfolds 3D interactions into dynamic 4D manifolds—allowing for realistic simulations where gravity or friction "bend" paths.

Quaternion rotations use 4D vectors to program smooth orientations without gimbal lock, representing 3D rotations as points on a 4D hypersphere—essential for animating complex movements where motion's "twist" becomes a spatial property.²⁴ By embedding rotations in four dimensions (three for direction, one for angle), quaternions avoid singularities in 3D space, enabling fluid flips or spins that treat orientation as a continuous 4D interpolation.

Taken together, these examples reveal a profound truth: the

²³ See, for example, Blender, Maya, Unity's PhysX, and Unreal Engine documentation.

²⁴ Gimbal lock is a problem in traditional 3D rotation systems where two rotation axes align, causing a loss of one degree of rotational freedom. This leads to unpredictable or "locked" behavior. Quaternions avoid this issue by operating in four dimensions.

mathematics of motion is already represented through 4D geometry. To embrace 4D geometry fully, we must recognize motion as the fourth fundamental capacity of spatial existence—the essence that these 4D coordinate systems uniquely describe.

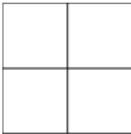
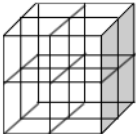
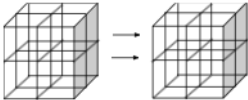
“Squaring” Motion

D’Alambert mentioned that “the product of time by solidity would in some manner be a product of four dimensions,” which hints at multiplying a solid by instances of time. This reminds me of an exercise I attempted when I first had the idea of motion as the fourth dimension. It was more than just an exercise in numbers to see how the math would add up, but a conceptual undertaking to discern what pattern of motion would follow the symmetrical progression from a line, to a square, to a cube. As earlier pointed out, these shapes are commonly used because of their symmetry, making the patterns that follow through the recursive progression easy to anticipate, so I began to wonder what a perfectly symmetrical form of motion would look like.

To help me, I went back to the numbers of recursive progression, not of the edges, faces and solids, but of the end product of quantifying these shapes. What happens when we square a 1m line? We get a 1m^2 square. Then, when that square is then cubed, we get a 1m^3 cube. What happens then when we stretch it into the next dimension? Naturally we should get 1m^4 , but how is that represented?

This exercise is more easily comprehended when we take a step forward quantitatively. If we measure the line to 2m, then pull it out another 2m in a different spatial dimension, a 2D plane of four “square” metres is created, which are four 1x1m squares equalling to 2^2 , or 4m^2 . Then, pulling that 4m^2 square out 2m in a different spatial dimension creates a 3D cube of eight 1x1x1m cubes equalling 2^3 , or 8m^3 (see below).

So far the pattern follows basic exponential math and everything makes perfect sense. How, then, do we express the next step from 8m^3 to 16m^4 ? Through the idea of this book, proposing motion as the fourth order of spatial dimensions, enabled by time, let’s pull the 8m^3 cube through that spatial dimension of motion by moving it 2m in any direction. That gives us the 8m^3 cube of the first position and the 8m^3 cube of the second position which total to 2^4 or 16m^4 .

1 Dimension	2 Dimensions	3 Dimensions	4 Dimensions
2m 	4m^2 	8m^3 	16m^4 

As happy as I was to see this, the exercise does not work the same way if we take another quantitative leap by changing the original size to

3m. In that case we would get a line of 3m , a square of 9m^2 , a cube of 27m^3 and then the two copies of 27m^3 to make 54m^4 which does not equate to the anticipated next step of 3^4 which is 81m^4 . Progressing this in the same way as we did the 2m line doesn't add up mathematically. If we try the same thing with a base size of 1m we also get different results: a 1m line, a 1m^2 square, a 1m^3 cube, then we move the cube 1m in any direction and the two copies of the 1m^3 equate to 2m^4 , not the mathematically anticipated 1m^4 . So what is the “squaring” or “cubing” equivalent of 4D motion that will get the right results?

I then worked out that the correct results can be obtained, not by moving the cube in the same quantitative distance and recording only two instances, but instead recording the same amount of instances through time of the base quantity. With the measurements we are using, as the numbers rise, in a way we are simply getting more detailed about the same shape, cutting it up into more and more segments, increasing the divisions within it. We can do the same with its path of motion by measuring a certain amount of instances of time. So for the 1m^3 cube we only record one instance of time to get a 1m^4 result²⁵. Then, with the 2m line leading to a 4m^2 square 8m^3 cube, we record two instances of time (the base quantity of the scenario)— 8 times 2 which is 16m^4 . Finally, with the 3m line leading to a 27m^3 cube, three instances through time are

²⁵ Some might think, well in one instance it would just be a static 1m^3 , and perhaps that is true, but we can conceive of it existing within time, so we can attach a measurement of time to it, as any static frame in a video still has a measurement of time attached to it.

recorded, giving us the 27m^3 cube captured at three instances of time, or 81m^4 .

Now, notice that we arrived at the correct results not by considering the original exercise of including motion, but instead only by considering quantities of instances of time. So does that go against this book's main idea, strengthening the conventional view that it is time alone that constitutes a fourth dimension? I hesitate to think so, mostly because of what was discussed previously about motion being the spatial expression of what time enables, and its capacity therefore a better candidate for a fourth *spatial* dimension. Again, motion and time are so interrelated that the capacity for one demands the capacity for the other.

Nevertheless, these are mostly just exercises in symmetry. As a line is squared evenly, the square is cubed evenly, how is the cube "moved" evenly? Surprisingly, the tesseract gives us the answer, as through this book's interpretation we see it moving from one point to another through equal expansion/contraction of all parts, which seems to be a better example of the perfectly symmetrical motion I was looking for.

Addressing Common Objections

I hope it's been made clear so far that the systems of 4D geometry are not only entirely capable of describing the motion of 3D objects through space and time, but they are the systems best suited for it. Across

real-world technologies 4D mathematics has emerged as the natural language of motion, yet few have taken the final conceptual leap to see motion not merely as something that unfolds within four dimensions, but as part of what defines that fourth spatial dimension itself. This book asks why that step has remained unspoken—and why now is the moment to take it.

Objection 1: *“Motion is a process of change, not a dimension.”*

This view is deeply rooted in Western philosophy and physics. Aristotle treated motion (kinesis) as a process—the actualization of potential—never as a spatial feature. Newtonian mechanics reinforced this by defining motion as the derivative of position with respect to time, a measure of change rather than a spatial capacity. With Minkowski’s spacetime (1908), motion was formalized as a worldline through 4D spacetime—where time was the fourth dimension.²⁶ These traditions form the intellectual scaffolding of modern physics, in which dimensions are conceived as either static directions (space) or temporal ordering (time), but not as the measure of dynamic transformation.

Response: Across both applied technologies and theoretical models, motion is already expressed through 4D geometric frameworks. Nowhere is this clearer than in the animation of objects—such as the tesseract example in this book—whose expansion and contraction reveal a shifting,

²⁶ Minkowski, “Space and Time” (1908).

spatially anchored structure: geometry in motion, conceptualized as a fuller 4D form beyond a static, unmoving object. Rather than contradicting Aristotle, Newton, or Minkowski, this perspective complements their legacy. It reframes motion as an additional expression of dimensionality within both space and time. Motion—long treated solely as temporal change—remains so in part, yet also emerges as spatial form: a dimension we have modeled mathematically for decades through 4D geometry, but never fully connected to the movement of 3D objects and the geometry its pathways produce.

Objection 2: *“We can’t properly visualize a fourth spatial dimension as three-dimensional beings.”*

It is true that the human brain perceives three spatial dimensions—length, width, and height. A fourth static spatial axis is neither directly observable nor easily grasped. We can describe it mathematically—via hypercubes, tesseract, or abstract coordinates—but struggle to visualize it, much less accept it as physically real.

Response: The obstacle is not purely visual—it lies in how we frame the act of visualization itself. We falter when we try to imagine a 4D form as static, yet the fourth dimension, as presented in this book, is not a frozen extension like height or width—it is a spatially structured transformation unfolding through time. The key is not to picture a static shape protruding from an object, but to perceive the processes of change that

shape undergoes through both 3D space and a fourth non-spatial dimension of time (spacetime). Dynamic visualization bridges this gap. Animating the tesseract—as a cube expanding and contracting—reveals motion through space as a geometry emerging through transformation. The fourth spatial dimension, then, is not an invisible axis to be guessed at, but motion’s own geometry made visible. The challenge shifts from imagining the unseen to perceiving the geometry of an event of motion.

Conclusion: Some may still hold these objections—recasting motion as a dimension can feel like stepping off familiar ground. This work does not reject tradition, though, it builds upon it, adding a perspective that has been hiding in plain sight. The mathematics, visualizations, and structures of 4D systems converge toward a compelling insight: motion is not merely something observed within three dimensions—it is what can define the next spatial extension to be. To see it this way is not to abandon our current understanding, but to expand it into a richer, more complete geometry of reality.

3. Laws of Motion

Isaac Newton laid out what are termed *laws of motion*, but they seem to be more accurately *laws of force* since they describe only the energy interactions of objects in motion. As with time and motion, motion and force are intrinsically related, and chapter five, *The Fifth Dimension: Force, A Matter Manifest*, will deal with how that might further progress the order of dimensional understanding presented in this book. This current chapter will consider the properties purely of motion without considering force, part of a field known as *kinematics*.

While developing the idea of this book, I felt it necessary to develop my own set of axioms to help me define the properties and rules of motion apart from force. During my research, the consideration seemed absent from the field of physics, and another concept I found absent was a crucial part of the definition of motion that considers change *within* an object, without reference to another object.

As of this writing, Oxford Reference defines motion as:

“a change in the position of a body or system with respect to time, as measured by a particular observer in a particular frame of reference.”²⁷

²⁷“Motion,” *Oxford Reference*, accessed June 2025, <https://www.oxfordreference.com>.

While accurate within the scope of classical physics, this definition omits a critical aspect of motion: self-relative change. Objects do not only change position through space, they can also change in relation to themselves. A shape that stretches, contracts, or morphs from one form to another is undergoing motion even without displacement. This is what I refer to as motion by formation—internal transformation that generates a new geometric structure. Notably, this idea echoes the classifications offered by the ancient Indian teacher Rishi Kanada, who, over 2000 years ago in the *Vaisheshika Sutras*, not only described concepts resembling Newton’s laws of motion, but also distinguished between external locomotion and internal acts such as expansion and contraction.²⁸

While the Oxford definition describes external motion—movement through space relative to an outside observer—it does not capture the full geometry of motion as it relates to internal formation. The definitions proposed here seek to include both.

²⁸*Vaisheshika Sutras* (composed between 6th–2nd century BCE), attributed to Rishi Kanada.

Axioms and Laws of Motion

The following axioms describe motion, not solely as the effect of force, but as the transformation of both spatial position and form.

1. Motion is the change of an object's spatial occupancy of form, rotation or position in space.
2. Objects move in relation to other objects by change in position or rotation.
3. Objects move in relation to parts of themselves by internal transformation.
4. All motion occurs along—or between—six directional axes, as perceived by an observer: forward/backward, left/right, and up/down.
5. Velocity is the rate of motion over time.
6. Acceleration and deceleration are changes in the rate of velocity.
7. A turn is a change in the spatial direction of motion.
8. Motionlessness is unchanging spatial occupancy.
9. Motion can unfold across one, two, or three spatial dimensions:
 - a. In one direction its geometric history traces a line.
 - b. With a turn in a second direction its geometric history is two-dimensional.
 - c. With turning across all three axes its geometric history is three-dimensional.

Motion Before Force: A Forgotten Lineage

It is worth pausing here to expand on the ideas of Rishi Kanada, previously introduced. In the *Vaisheshika Sutras* (composed between the 6th and 2nd centuries BCE), Kanada treated motion (*karma*) not as a derivative phenomenon but as one of the fundamental categories of existence, alongside substance (*dravya*) and quality (*guṇa*). Strikingly, he classified motion into five types: upward, downward, contraction, expansion, and locomotion. This inclusion of contraction and expansion—forms of internal transformation rather than mere external displacement—anticipates a self-relative view of motion that modern kinematics has often overlooked.

While contemporary physics discussions of motion are almost always tied to force, the separate study of kinematics—the geometry of motion independent of its causes—has a long and distinguished lineage. From Zeno’s paradoxes in ancient Greece to the graphical methods of Nicole Oresme in the 14th century, thinkers have sought to describe motion as a geometric phenomenon in its own right. Later, Galileo’s experiments with falling bodies, Newton’s formalization of the force-motion relationship, and the 19th-century naming of kinematics by André-Marie Ampère all built on this foundation. Engineers such as Franz Reuleaux and Ludwig Burmester further advanced the field by treating motion as systematic transformations in space.

4. Time

“Wherever anything lives, there is, open somewhere, a register in which time is being inscribed” —Henri Bergson

I’ve been hearing people ask for years, “does time exist?” Whenever I hear that question, I can’t help but feel bothered because the answer seems very obvious. Articles on the subject still appear regularly in science news feeds—what I suspect to be no more than clickbait, designed to spark controversy and drive up visitor numbers to a publication. My own response has always been simple: yes, as a measure of duration.

As pointed out earlier, the passage of time stems from the existential capacity for duration, which, together with the existential capacity for space, is itself a potential for motion. Time and motion are intrinsically linked. Time is how we measure motion, yet motion is also how we measure time, so in a sense, we are using motions to measure other motions, and we call the observation of it time. We mark it using repeatable cycles such as the Earth’s spin and orbit, atomic vibrations, the span of a force or a pulse, effectively relying on constants of motion that repeat with precision. These regular cycles allow a synchronization, the sharing of a common rhythm between perspectives, whether for science, music, communication, or simply marking a day.

As long as things move, time will remain part of our method for

describing spatial change. If there were no capacity for movement, as Aristotle reasoned, time might not exist at all and the world would be an unchanging state.²⁹ Yet, if all things were motionless, there still exists a sense of duration. Philosopher Henri Bergson makes a distinction with his concept of *la durée*, which separates measured time from experienced time.³⁰

From a human and conscious perspective, time is the measurement between two instances within our ever-existing state known as *the present*. We cannot escape this state. Events pass through it that we can remember as the past, and we can also imagine and anticipate the future—but we always live in what we call “now.” Does being permanently in “now” make us timeless? No, because we experience the duration of events as they pass through our perspective, made possible by our conscious capacity for memory. Is time itself a dimension? Yes, as a non-spatial capacity for duration that also enables a fourth *spatial* dimension of motion—together what might even be called *motion-time* or even *space-time-motion*.

A Brief History of the Question of Time

Though it may feel like a modern dilemma, the question of what time truly is has echoed through human thought for millennia. From ancient

²⁹ Aristotle, *Physics* IV, 11 (c. 350 BCE).

³⁰ Henri Bergson, *Time and Free Will* (1889) and *Duration and Simultaneity* (1922).

Greece to quantum physics, thinkers have wrestled with whether time is real, emergent (i.e., arising as a higher-level property from more fundamental, non-temporal processes), or simply a construct of the mind. Aristotle, writing in the 4th century BCE, defined time as “the number of motion in respect of before and after,” grounding it firmly in change.³¹ If nothing moved, he reasoned, time would not pass. Centuries later, St. Augustine famously confessed, “What then is time? If no one asks me, I know; if I wish to explain it to one that asketh, I know not.”³² For Augustine, time was inseparable from consciousness: the past exists only in memory, the future in expectation, and the present in fleeting awareness.

In the scientific tradition, Isaac Newton described time as absolute—a universal, steady flow that would continue even if nothing happened—while Gottfried Leibniz countered that time was purely relational, existing only as the ordering of events.³³ This debate set the stage for the 20th-century’s shift. Albert Einstein’s theory of relativity fused time with space into a single four-dimensional continuum—spacetime—where time could stretch, slow, or even stop depending on speed and gravity. In a 1955 letter, he wrote that “the distinction between past, present and future is only a stubbornly

³¹ Aristotle, *Physics* IV, 11.

³² St. Augustine, *Confessions*, Book XI (c. 397–400 CE).

³³ Isaac Newton, *Philosophiæ Naturalis Principia Mathematica* (1687); Gottfried Wilhelm Leibniz, correspondence with Samuel Clarke (1715–1716).

persistent illusion.”³⁴

Not everyone accepted Einstein’s interpretation of what this meant for lived time. Henri Bergson, in his 1922 critique, agreed that relativity’s equations correctly predict what moving clocks will show—but he insisted this is not the same as saying the flow of time itself is altered.³⁵ For Bergson, Einstein’s theory described the behaviour of measuring devices, not the nature of time. While numerous high-precision experiments—from the 1971 Hafele-Keating atomic-clock flights around the world to the continuous operation of GPS satellites and muon lifetime tests—have since confirmed these relativistic effects as real physical phenomena rather than mere instrumental artefacts, the deeper philosophical implications for the nature of time remain open to debate.³⁶

The claim of this book is ultimately that motion is what happens due to the non-spatial existential capacity of duration—what we call time. Further, the intervals we use to define increments of time are themselves based on motion, so the two are deeply interrelated. Since motion is what takes place within space, it is what qualifies best as the defining manifestation of the fourth *spatial* dimension. As Aristotle pointed out, to deny time’s existence one would have to imagine a world in which absolutely nothing moves. Even then, would some outside

³⁴ Albert Einstein, *Relativity: The Special and General Theory* (1916); letter to Michele Besso’s family (21 March 1955).

³⁵ Henri Bergson, *Duration and Simultaneity* (1922).

³⁶ Hafele–Keating experiment (1971); GPS satellite time corrections; muon lifetime experiments.

observer—perhaps a being like God, “beyond time”—still comprehend the duration of all things in perfect stillness? That, perhaps, is where the matter must ultimately rest.

5. The Fifth Dimension: Force, A Matter Manifest

*“What we observe as material bodies and forces are nothing but shapes and variations in the structure of space.” — Erwin
Schrödinger*

This chapter explores how the preceding idea of this book, that motion should be regarded as a fourth spatial dimension, may lead us to consider a fifth spatial dimension in a similar way—not defined by a purely spatial extension, but still expressed within space as what seems to be the most natural progression from motion: *force*. Like motion, force is not a new static directional axis through space, yet it connects spatially to lower dimensions and introduces new measurable elements within them. Force directly shapes the behaviors of an object’s motion through space and time; it is what allows objects to cross the threshold from form and movement into *effect*. It is here proposed as the final spatially-oriented dimension that makes existence *physical*.

Continuing Recursive Progression

As defined in this book, a 4D form is any 3D form with a capacity for motion. In a purely 4D world of motion, two objects that move into the same space would simply pass through each other, untouched by any notion of physicality. In the real world, however, when two objects converge, something different happens: force manifests—not as a new static axis, but as a magnitude of energy that can affect the geometric nature of both the motion (4D) and the form (3D) of objects interacting.

Going back to Hinton’s method of recursive progression, we can conceive a 5D progression of a cube (a penteract) as two 4D hypercubes joined by new directional edges and reinterpret this using motion and force as our new perspectives. As the tesseract-projection was shown to represent the motion of a cube expanding or contracting, imagine a possible progression of that scenario: a smaller cube expanding within a larger cube that is contracting—a *hypercube nested within a hypercube*, each tracing its own 4D pathway through space and time. What exactly would new edges connecting them represent?

I propose new “5D edges” connecting hypercubes to be any events of force where and when the two cubes interact. In the example above, the smaller expanding cube and the larger contracting cube will eventually make contact, causing force events to happen across every corner, edge, face and volume that collide. These events of impact are new measurable happenings in space that, while they are not entirely spatial in character like new directions extending into space, they do

remain connected to places where they occur as *spatially anchored* forms of measurement.

These 5D events of force have the capacity to modulate the 4D qualities of motion which in turn have the capacity to modify the 3D qualities of form of each object involved—altering their position, formation, acceleration or trajectory through space and time. Whereas motion is a 4D spatial capacity that can change the 3D form and position of objects, force is a 5D spatial capacity that can change the 4D motion of 3D objects. This is where Newton’s laws of motion finally come into play.

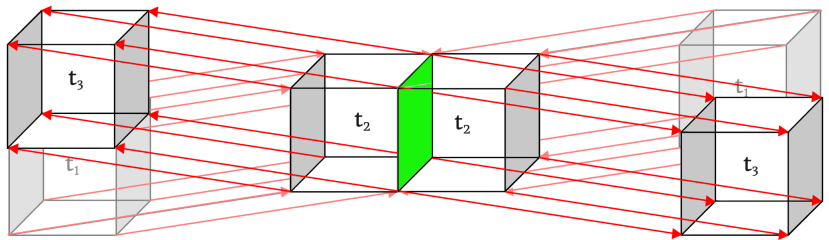
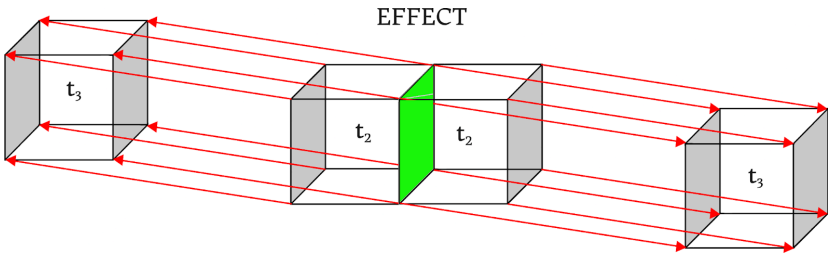
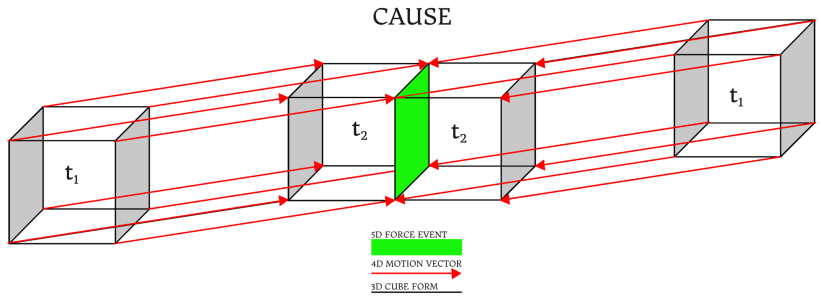
Quantifying Force Through Cause and Effect

Remember how the new “4D edges” of the tesseract were interpreted to represent motion-vectors, with direction and distance associated with each of them. When temporal coordinates were given, measuring the duration between the initial and final states of the cube allowed us to infer the velocity of the cube’s motion. Likewise, for the new “5D edges” that would represent force interactions, instead of velocity, we can infer the magnitude of force with each instance of impact by examining the resulting change in velocity (acceleration). To do that we must measure the velocity of an object both before and after the interaction.

As we showed the two cubes of the 4D hypercube to represent one cube at different points in time, for a progression toward a 5D

geometry of force, one hypercube could represent a causal state (the motion that led to the force interaction), and another could represent an effect state (the motion that was the result of the force interaction) for any of the objects involved in the force event. So, when two objects in motion collide, each has both a causal state and an effect state that can be expressed as 4D hypercubes (3D motion paths); the instant and location of their meeting is the “5D edge”—but here we do not need to draw new static lines to represent the 5D force events; we can simply just anchor a form of information to that place and time.

The images on the next page show two hypercubes (cubes in motion, as this book defines) colliding via positional motion, connecting at a new “5D edge” where and when they meet. Instead of just passing through each other in a world of purely 4D motion, the fifth dimension is experienced as the spatial effect of force. It is not a new geometric extension, but a capacity of effect that is spatially anchored. More than an effect, force is also a cause, and a full observance of a force event requires an observance of both cause and effect states.



In the first image of the cause state, two cubes in motion (from t_1 to t_2) are shown to collide. The second effect state shows the result after the collision. The third image combines the two states to show the whole process.

For anyone familiar with basic physics, they will know that part of the inferred magnitude of a force event comes not just from the change in velocity (acceleration) of the objects affected, but from another crucial property of the objects themselves: their *mass*. When we enter into the dimension of force we are now forced (pun intended) to regard it as an all-pervading dimension within 3D objects. Force does not only occur at points of interaction; it is rooted in the very internal energies that compose matter, famously exemplified by Einstein's $E=mc^2$.³⁷ Mass itself is concentrated energy—bound in extraordinarily stable configurations, waiting to be released by an introduced “unbalanced” force. In this sense, every material object is already a 5D entity: its 3D form is sustained by ceaseless 4D motion, and its mass is the measure of how much 5D capacity it carries within it.

This is something to consider if we are to find the symmetrical progression from a 3D cube to a 4D tesseract to a 5D penteract through our idea of form, motion and force. To observe a 5D element we must observe both a cause and an effect related to the force event, like in the example above, not just measuring between two points in time, but triangulating three moments to measure an initial velocity, a moment of force, and then an exit velocity. We could also triangulate a moment of force, the resulting velocity, and then the next moment of force, which for our tesseract-within-a-tesseract example may be necessary.

³⁷ Albert Einstein, “Does the Inertia of a Body Depend Upon Its Energy Content?” (*Annalen der Physik*, 1905).

Completing the Penteract

Geometrically, a penteract is calculated to be composed of 10 hypercubes (what this book regards as 3D forms in motion), 40 solids, 80 squares, 80 edges and 32 vertices.

In the case of a single contracting cube, the cube will eventually collapse into a singularity, drawing the familiar tesseract-projection as it does, with 6 solids within the cube showing the trace of the corners as it shrinks into the smallest possible cube, all sides compacted. In the penteract, these 6 solids are conceptual forms undergoing change, accounting for 6 of the 10 hypercubes. Traditionally, the tesseract projection considers the outer cube and the inner cube as separate solids, each being translated into separate hypercubes in conceptions of the penteract, but this book interprets them as a single cube in motion, so we will regard the two as actually just one cube in motion, accounting for one of the hypersolids.

At the point of impact at the singularity, the cube will then rebound into opposite directions of space, retracing a new hypercube representing the cube now expanding along the same 6 hypercube paths toward another point in time. The cube collapsing before the force event accounts for one hypercube, and the same cube expanding after the force event accounts for another hypercube. Along with the 6 sides, that makes 8 total.

Some might think, do we count 6 new hypercube sides traced by the new expanding cube? What I considered is that the 6 hypercubes are conceptual traces, and through this symmetrical event are simply reused paths, so I kept them as 6.

The last thing to consider here is the mass of the cube's entry state and the mass of the cube's exit state. We propose these to be two hypercubes themselves, representing the internal motion states of the cube's materiality. This completes the 10 hypercubes of the penteract. The complete cycle unfolds into ten hypersolids: the initial contracting motion hypercube and its mass hypercube of the causal event, six transitional volumes swept by the moving faces, and the final expanding motion hypercube and its mass hypercube of the effect event.

This tenfold symmetry resonates with the structure of particle physics. Every interaction is framed by an initial state, a moment of force, and a final state, with mediating propagators and conservation laws binding them together. The causal motion and effect motion hypercubes mirror the incoming and outgoing trajectories of particles, while the six transitional hypersolids echo the internal channels through which interactions unfold. The two mass hypercubes embody the conservation of energy-momentum, anchoring the system before and after the event. In this way, the penteract's ten facets are not abstract geometry alone but a dimensional analogue of particle interactions: geometry, motion, and causality balanced in the same way that physics balances states, mediators, and conservation principles.

This structure also finds a natural parallel in Feynman diagrams, which depict interactions of particles through incoming and outgoing lines connected by internal propagators. Just as the diagram organizes trajectories, mediators, and conservation anchors into a coherent picture of an event, the penteract organizes motion, force, and mass into a tenfold symmetry. Both systems reveal that what appears as a single interaction is in fact a collective of varied states and mediating channels bound together by conservation laws.

Subtler Forces

The penteract serves as a minimalistic demonstration of dimensional symmetry, tracing the progression of a specific shape, a cube, through higher forms. The real world is not built from only cubes, however, but from spheres and fields mostly, spinning, traversing orbits and having other forces spin around them, like the electrons around an atom. We move beyond straight edges, planes and cubes into curves, fields, frequencies and irregular motions as we encounter a spectrum of forces that govern the external and internal motions of objects—gravity, electromagnetism, radioactivity, quantum behaviours, and heat. Here we must consider a step in our development that envisions force not merely as the outcome of two objects meeting in space, but as an effect that operates across distances as subtler forces that work between objects and also within their makeup of matter.

How might this be expressed within our framework where 5D force causes the 4D motion changes of 3D forms? For the contracting cube example, a cause of the contraction might be a surrounding force (a bigger cube that was contracting that collided with the smaller cube which was expanding, causing a reversal of motion), or alternatively it might be an effect of gravity, pulling the mass of the cube back into itself to a central point. How would that be expressed geometrically as a hypersolid? Perhaps as a sort of hyperfield emanating from the substance of the cube, representing attractive forces, pulling all the matter towards itself into the singularity, leading to a big bang-like event that disperses the matter outward again.

We must also consider other forms of forces that sometimes come as a result of the surrounding environment. Objects hold internal properties such as heat, that spreads within an object and also radiates outward from it into other objects. As we know, heat has a very interesting relationship with matter, changing it into its varied states, from solid, to liquid, to gas and to plasma, showing how systems of force are deeply tied to the makeup of the forms we daily interact with. Also, if surrounding fluids are involved, they will be affected, sometimes producing what we hear as noise, whether a loud bang from a collision or a steady hum from internal energies at work. These are all events of force that propel energy through space, capable of being somewhat represented geometrically.

Sidenote: The Four Elements Reconsidered

As heat is mentioned as governing the states of matter, I feel led to interject a thought here about a common understanding of physical reality I have not seen discussed often. Growing up, I—like many—assumed the ancient idea of four elements (earth, water, air, fire) was quaint at best, and laughably outdated at worst. After all, how could four poetic “essences” compare to the rigor of the periodic table? But later in life, I realized something striking: these classical elements align almost perfectly with what we now call the states of matter. Earth corresponds to solids, water to liquids, air to gases, and fire to plasma, the high-energy state where matter becomes ionized. It turns out the ancients weren’t so far off; they were simply describing matter as they experienced it, through the lens of transformation and sensation.

This connection has been noted by historians and philosophers alike. The Wikipedia article on classic elements acknowledges that while modern science no longer uses these categories, the ancient framework “roughly corresponds” to the states of matter under different energy conditions.³⁸ Essays like *Earth, Air, Water and Fire: The Verticality of The Classical Elements* go further, exploring how these elements were intuitive attempts to describe the physical world based on direct sensory experience.³⁹

³⁸ https://en.wikipedia.org/wiki/Classical_element

³⁹ <https://www.onverticality.com/blog/earth-air-water-fire>

A Hidden Dimension?

Surprisingly, the idea of force as a spatially-anchored dimension is not entirely new. It echoes early 20th-century insights from Theodor Kaluza and Oskar Klein, who sought to unify gravity and electromagnetism by extending Einstein's general relativity into a 5D model.⁴⁰ In their framework, Kaluza-Klein theory, force did not arise as a separate entity, but as a geometric consequence of an additional spatial dimension beyond the four of spacetime. Kaluza discovered that the extended equations naturally split: one part described gravity, while the other mirrored Maxwell's equations for electromagnetism—suggesting that electromagnetic force could be interpreted as curvature in a hidden dimension. Klein refined this idea by proposing that the fifth dimension is compactified—curled into a tiny, imperceptible loop at every point in space.

After encountering their work, I was pleased to find their attempt to describe force through a 5D geometry. Yet my approach differs: rather than imagining a compactified dimension pervading all space—akin to the historical concept of an aetheric field once thought to fill the universe—I propose that the fifth dimension manifests through matter and energy only where it already exists. In this view, space remains an empty field, and dimensional properties are not embedded in the void but anchored to objects and their forces already at play.

⁴⁰ Theodor Kaluza (1921) and Oskar Klein (1926). See also: "Kaluza-Klein theory," *Stanford Encyclopedia of Philosophy*.

Kaluza-Klein theory fell by the wayside for decades but was revived in the 1990s by Paul Wesson's space-time-matter theory, culminating in the 2018 book *Principles of Space-Time-Matter* (completed by his collaborator James Overduin after Wesson's passing). From the preface of the book:

“The theory of Space-Time-Matter uses the geometry of the fifth dimension to explain the matter in the world. It has something in common with Einstein's 4D theory of general relativity and its 5D extensions due to Kaluza and Klein. However, STM has an energy-momentum tensor which is derived from an extra dimension that is not rolled up or compactified to an unobservably small size. In fact, we see evidence of the fifth dimension in things from the mass of an elementary particle to the density of the cosmological fluid. In this way, STM theory fulfills Einstein's theorem of transmuting the “base wood” of matter to the “fine marble” of algebra.”⁴¹

Near the end of the book it is explained further:

“Space-Time-Matter theory is a logically minimal extension of general relativity that realizes Einstein's dream in both senses. The metric structure of the 4D theory is inherited and merely extended to one additional coordinate. Fields are unified

⁴¹Paul S. Wesson and James M. Overduin, *Principles of Space-Time-Matter: Cosmology, Particles and Waves in Five Dimensions* (2018).

physically with their sources by deriving the 4D field equations with matter from the 5D Ricci equations in vacuum. That this can always be done is guaranteed by Campbell's embedding theorem (Chapter 2). It is intriguing that this theorem appeared in 1926, the same year as Klein's compactification of Kaluza's fifth dimension. Compactified Kaluza-Klein theory went on to become the basis for most work on higher-dimensional unification, while Campbell's theorem languished in obscurity. Einstein, as we know, worked on his own 5D theories with Jakob Grommer in the 1920s and Peter Bergmann and Valery Bargmann in the 1930s. Nowhere did he express the nature of his quest for unification more clearly than in his paper with Grommer:

*"We presently have in mind as ultimate goal a pure field theory, in which the field variables produce the field of 'empty space' as well as the ... elementary particles that constitute 'matter'."*⁴²

⁴² Ibid.

The Bridge to Consciousness

In the world we live in, we detect some of the forces and the changes they make to the physical world through our senses which render them into experiential realities, acting as living interfaces that translate force into perception. *Sight* captures electromagnetic force, where photons, carrying momentum, interact via absorption or reflection; the eye, tuned to a narrow frequency band, transforms these oscillations into colors, rendering electromagnetism's blue waves as visual spectra. *Touch* registers force directly: pressure, texture, or heat's conductive warmth deform the skin, with mechanoreceptors signaling gravity's weight or collision's impact in 3D space. *Hearing* detects vibrational force—sound waves as pressure fluctuations through air or matter—converted by the ear into tones, echoing convection's rhythmic swirls. *Smell* perceives chemical force, as airborne molecules bind to olfactory receptors by shape or charge, a molecular dance akin to radioactivity's quantum bursts. *Taste*, through direct contact, senses chemical interactions, with tastants triggering tongue receptors to reveal molecular bonding as flavors.

These effects of forces are detected through the senses of beings endowed with what seems to connect to a new existential realm beyond physical space—consciousness. While our brains and minds do operate within our spatial world shaped by the first five existential capacities (form, motion, and force), consciousness itself appears to function as a non-spatial backdrop, an arena in which the effects of lower dimensions are registered, processed, and given meaning. Some philosophers and

physicists speculate that the intricate interplay of forces might generate consciousness or even enable access to it. Is consciousness itself the next dimension, where the capacities of force are infinitely replicated in new capacities of the mind? What I think makes more sense is that, like the void of space where the capacities of physical reality occur, consciousness itself seems to be more of an existential backdrop where the capacities of the mind occur. Some even propose consciousness as the foundational strata of existence, essential to all experience. From an individualistic standpoint that is very well true, but perhaps not from a purely objective reality, unless it is a higher divine consciousness that enables the existence of all objective reality. I will not comment or expand on that here, but instead venture toward a continued progression of dimensional consideration that the next chapter will explore, by dissecting what does exist within consciousness, perhaps as its primal manifestation: *possibility*.

6. The Sixth Dimension: Possibility, Beyond Space

“When you have exhausted all possibilities, remember this: you haven’t.”

—Thomas Edison

The proposals up to this point have addressed the measurable aspects of physical reality: first outlining the foundational three axes of space, then introducing the motion of 3D forms as a fourth spatial dimension (or existential capacity), and finally describing events of force interaction as a fifth dimension. Together, these five spatially-tied dimensions appear to complete a framework for describing the entirety of the physical universe.

Yet beyond this, a new step seems inevitable—one no longer rooted in space. To explore further dimensional intricacies, we must shift focus from *what is* to *what could be*—a basic form of conscious awareness we can categorize as *possibility*. Rooted in a basic knowledge of the world, it is the extension of the mind to consider what may be based on what exists in physical reality. Entwining with our mental abilities to observe and remember, it is also a cornerstone of scientific reasoning: first we observe the structure and function of the physical world, and from that

foundation we begin to predict—to ask what could follow, what alternatives might emerge, and how systems can be influenced or shaped. Further developments of higher reasoning will be dealt with in the next chapter; for now we focus on this simple process of *knowing*.

Geometry of the Unmanifest

If the fifth dimension can be described by hypercubes interacting through dynamic forces, then the sixth dimension would replicate all the possible realities of those interactions themselves, stretching them into an infinite array of potential outcomes. Just as a 1D line extends with infinite parallel copies (yet constrained within a plane) to form a 2D square, and a square to a 3D cube, the sixth dimension replicates the possible states of lower-dimensional systems of 5D force under conditional constraints.

This mirrors Hilbert space in quantum mechanics—a structured, high-dimensional framework where every possible state of a system is encoded as a vector, bound by norms and operators that tether its infinite results to the system’s rules.⁴³ Envisioned as a constellation of possible states within one system, this sixth-dimensional space captures all latent outcomes.

Any “new 6D edges” connecting two 5D penteracts (events of

⁴³ See, for example: David Hilbert, “Grundzüge einer allgemeinen Theorie der linearen Integralgleichungen” (1904–1910); modern treatments in quantum mechanics textbooks.

force through cause, effect, and conservation of energy) could represent that constellation of events as alternate realities connected to the boundaries of the system. In our earlier hypercube progression, symmetry was preserved by assuming equal forces, motions, and forms; here, in this sixth-dimensional field of potential, we systematically vary inputs—direction, velocity, acceleration, or mass—and observe the cascade of results. We explore multiple variations of a state, forming a database of if–then conditionals, as seen in computer programming:

If the velocity of one hypercube increases, then the other deforms.

If acceleration rises and a vertex twists, initiating rotation, then a spiral shear emerges.

Each “5D slice” of a full 6D system of infinite potentialities, representing one specific interaction scenario, could itself be a very complex outcome.

As the sixth dimension transcends physical interactions, it enters a logic domain of structured potential, where the concern is conditional: what outcomes are permitted within a defined system? This shift places us in *computational epistemology*—the study of knowledge through computational models of possibility—where systems are explored not via spatial coordinates but through interplays of conditions, much like algorithms navigating Hilbert space. Related fields include *discrete mathematics* (branching pathways), *automata theory* (state transitions), *category theory*, and *modal logic* (necessity and contingency). At this level

we map all a system could do, without yet invoking choice or probability—facets of a higher logic explored in the next chapter.

Measure of Possibility

In the scientific world, *entropy* defines the magnitude of possibility—measuring how many ways a system can be arranged while appearing the same to an observer. Just as the sixth dimension stretches lower-dimensional realities into an infinite array of potential outcomes, entropy quantifies the scope of these possibilities within constrained bounds. A perfectly ordered deck of cards has low entropy (one unique arrangement); a shuffled deck yields over 10^{68} possible configurations, all indistinguishable as “random.” Entropy, then, counts the infinite results hidden within a single observed state. With possibility conceived as the sixth dimension—a structured space of what could be—entropy becomes its natural metric, measuring the density of possible states within conditional constraints.

In statistical mechanics, entropy is rigorously defined in six-dimensional phase space, where each particle’s state is described by three spatial coordinates (x, y, z) and three momentum components (p_x, p_y, p_z).⁴⁴ A single particle inhabits this 6D space of possibilities; for many particles the space expands exponentially. Entropy measures the volume

⁴⁴ See: Ludwig Boltzmann, *Lectures on Gas Theory* (1896); modern statistical mechanics texts (e.g., Pathria & Beale).

of results the system explores—a computational metric of freedom within constraint.

This phase space does not continue the exact pattern of our speculative dimensional framework (position, time, dynamic interactions), but it echoes its essence: a structured domain of potential outcomes. The same logic appears in molecular dynamics, where the Potential Energy Surface (PES) maps a molecule’s possible states as atoms shift, stretch, or rotate—each point a conditional outcome with an associated energy.⁴⁵ Quantum mechanics embraces this architecture even more directly: superposition encodes all possible results until observed, while Feynman’s path integrals sum every possible path a particle could take.⁴⁶

At its core, entropy traces the structured potential of the sixth dimension—not just local variance, but the full constellation of possible states within a system’s boundaries. The mind, like a computational system exploring these results, senses what is possible before reasoning or choice, setting the stage for higher logic in the chapters ahead.

⁴⁵ See, for example: “Potential energy surface,” *IUPAC Gold Book* or computational chemistry references.

⁴⁶ Richard P. Feynman, “Space-Time Approach to Non-Relativistic Quantum Mechanics” (*Reviews of Modern Physics*, 1948); See: Erwin Schrödinger, “Die gegenwärtige Situation in der Quantenmechanik” (*Naturwissenschaften*, 1935) — the famous “cat” paper.

7. The Seventh Dimension: Intelligence

“Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world.” — Albert

Einstein

Having explored possibility as the sixth existential capacity—the structured domain of what could be within consciousness—we now arrive at its natural extension: intelligence. This seventh dimension is the capacity to select, choose, and will from the infinite array of possibilities, simplifying complexity into directed action, understanding, and creative expression. It is the power that turns latent potential into lived reality, shaping how conscious beings navigate, respond to, and transform the world they inhabit through the lower dimensions of form, motion, and force.

Back to Basics

From the perspective of a living being, simple thoughts of observance give rise to ideas and fuller conscious conceptions as the mind is self-aware and connected to a body that interacts with the world, senses its many facets, explores its vastness and considers its own options—a

basic one of which is survival. Through the senses and appetites, the bodies of conscious beings indicate to the mind the primal needs to function and develop properly, and the behavioural traits of much of nature revolve around those core concepts. Behaviour and attitude are some of the basic outcomes of an intelligent consciousness, and as each conscious being has domain over itself, those things can become an indication of their current or overall conscious makeup, from basic intents to more complex emotional states.

Along with the body's innate urges to eat, drink, work and rest, there are also other cravings that drive conscious beings to make fuller use of the capacity of their senses. We also seek how to find and prolong the euphoric rewards that come with things like happiness, contentment, peace and security. Most often, relationships are formed to accomplish that need, sometimes as a way to make survival easier and sometimes for other crucial reasons as with the process of procreation where two beings come together to create a new life and provide for its growth and maturity. Through that and other forms of intimacy, deeper aspects of intellect can be shared and developed long-term, and more complex ideas and emotions can be nurtured over one's lifetime. Other simpler relationships seek to benefit from shared experience as we see with the application of learning, teaching, co-operation and even simple social relationships of encouragement and emotional support.

There have been distinctions made between animal intelligence and human intelligence, as the achievements of humanity seem to far

outweigh the accomplishments of all other animal societies. It is certainly apparent that humanity's intelligence is imbued with something far greater, and some point to scriptural reference of man being created in God's image and given special domain over the other orders of nature.⁴⁷ Intelligence as a whole is very well expressed throughout humans and animals, though, and many of the concepts in this chapter can apply to both, but the superiority of the human mind and spirit often invites its own unique categorization.

A Moral Debate

What a lot of discussions on intelligence come down to is a very important mode of reasoning that delves into ethics and morality, something individuals and even cultures and societies can struggle to master over the course of their life's development. It seems to be something all conscious beings are faced with, no matter how advanced their upbringing is, and it is a foundation of what parents teach children, and how a deeper quality of success in the world can be measured. Through the internal insights of balancing basic individual needs, to advancing those of the community, some beings can come at odds with external pressures and be compelled to react out of frustration, sometimes causing harm and destruction to the world. Often very complex and sometimes relative to certain situations, this issue can be

⁴⁷ Genesis 1:26-28

more easily understood through the dualistic lens of sin and virtue.

Sin is often seen as a form of selfishness. Without regarding consequences that may affect others, someone acts out of their own interests and leaves others to suffer (in the case of greed, one person takes more of what they need, leaving less and sometimes nothing left for others to have). To avoid sinful behaviours, which seem to develop naturally within humans from a young age, the principles and practices of virtues are encouraged to be learned and developed. Catholic Answers sums up the concept of virtue nicely:

“As the Catechism of the Catholic Church states, repeating the ancient wisdom of Aristotle and Aquinas, ‘A virtue is an habitual and firm disposition to do good’”⁴⁸

As ignorance, boredom and laziness often lead someone to simply appease base appetites, alternative pursuits founded in a desire to live a more noble and fulfilled life can lead us to explore how the development and growth of simple morals and virtues can lead to very pleasurable and lasting experiences in life. A basic pursuit of this has personally led to my own shift in understanding of the concept of working for a living. When I was younger and less mature, I dreaded thinking of a life forced to work 40 hours a week just to put a roof over my head and food on the table. As I began to study and apply virtues to

⁴⁸*Catechism of the Catholic Church*, 2nd ed. (1997), §1803.

my life, though, I realized the unique position I was in. I began to regard work not just as a forced obligation and see it more fully for what it is, an opportunity to bring joy into the lives of others. All of my efforts were in a way benefitting someone, and I could experience a wholesome satisfaction by acknowledging that.

Some might see all the good they do and get upset that only others are benefitting from what they are responsible for. This completely misses a crucial aspect of moral maturity. If we see that external benefit as something to be grateful for, we can actually begin to prefer helping others instead of hoarding all of the benefits for ourselves. There must be balance, though, as we can't expect poorly treated slaves just to be happy that they are pleasing their masters. There ought to be provisions from both ends, and in the case of standard employment, that is seen in a fair wage that gives the worker the ability to live a life of comfort and security. This is a clear example of how the practice of virtue can very easily steer a person away from habits and mindsets of sin and selfishness, and why cultures, especially religious ones, try to imbue this sort of thinking into people's consideration from a young age.

A Common Consciousness

Intelligence is not only an individual experience, it is also shared communally. This is where humanity's uniqueness comes in, from the use of tools, to the advancements of agriculture, architecture, societies

and civilizations. When asked what humanity's best invention is, common answers usually include the wheel or the printing press. I have regarded this question and given thought to something more basic: the invention of language and communication. It gives us the capacity to share our knowledge with others, at first just orally, and with later inventions of writing systems it turns into a capacity to record and preserve history. This invention is what makes the dimension of intelligence so fruitful, as individual ideas can spread and grow throughout the knowable world.

There is so much more that shared intelligence brings to life, as seen with the complex developments of expressions such as great works of visual art, literature, music, and other creative pursuits that add a very appreciated and emotionally impactful quality to a being's experience of reality. Nuances like humor and comedy are still being understood too, and the qualities that determine something to be beautiful sometimes vary from person to person, but in other cases are universally accepted. Cultural themes and trends also sprout up throughout history, some vanishing quickly and some persisting through or experiencing later revival. All are a reflection of shared interests that bond some groups of people together, and through that more intelligence can be sown.

In today's daily interactions with social media, many are compelled to influence others with their knowledge and ideas, spark a reaction, or just find something to jolt their own intellectual or emotional cravings. As a personal note, I'd like to add: with so much for our senses

to consume in this modern world, it is important to consider the virtue of temperance, or moderation of our appetites. Understand what those appetites are for in relation to both survival and pursuit of deeper fulfillments, and nurture them with care and consideration. Letting them go rampant can lead to forming long-term habits of misplaced intelligent and emotional focus—something that has been known to affect the mental health of many people.

Artificial Acuity

As we reflect on the arc of human intelligence—from primal instinct to abstract and complex reasonings on things like beauty and humour—it becomes clear that our minds have not only adapted to understand the world, but have also developed a capacity to replicate aspects of themselves within it. This drive to extend our cognitive reach has led to one of the most profound developments of our time: artificial intelligence. What began as a theoretical pursuit to model logic and decision-making has now evolved into a rapidly advancing field where machines can learn, adapt, and even generate novel insights.

What distinguishes artificial intelligence from traditional computation is its departure from rigid, rule-based instruction toward systems that can evolve through experience. Classical algorithms operate within deterministic frameworks, designed to execute predefined steps toward predictable outcomes. AI systems—especially those powered by

machine learning—operate in more fluid terrain. They sift through immense datasets, identify patterns, and produce outputs that surprise even their creators. These systems don’t just compute; they infer. They model uncertainty, suggest possibilities, and revise themselves—behaviors that echo human intelligence at its most dynamic.

In the language of our dimensional framework, this represents a striking manifestation of the seventh existential capacity. Modern AI operates in extremely high-dimensional latent spaces (mirroring the “constellation of possible states” of Chapter 6), navigating infinite potential outcomes before collapsing them through selection and optimization into purposeful action. Through techniques of dimensional reduction and adaptive feedback, these systems perform the essential work of intelligence: they select from 6D possibility and translate those choices back into effects within the lower dimensions of form, motion, and force. In this sense, AI is humanity externalizing the seventh dimension—creating tools that simplify complexity and turn possibility into purposeful reality.

Toward a Dimensional Synthesis

Looking ahead to what the next steps beyond this framework may be, it becomes increasingly clear that the systems we build—whether technological or conceptual—are growing in complexity. Yet the most advanced systems often seek simplicity on the far side of that complexity.

In fields ranging from physics to artificial intelligence, researchers are discovering that even the most intricate, multidimensional models benefit from frameworks that reduce noise, clarify structure, and reveal underlying order.

This tendency toward simplification is not a retreat from complexity, but a deeper mastery of it. Intelligence, as the seventh dimension, is precisely this capacity: the power to survey the infinite array of 6D possibility and distill it into meaningful, directed action within the world of 3D form, 4D motion, and 5D force. The seven-dimensional ontology proposed in this book is therefore not offered as a definitive solution, but as a conceptual framework—one possible way to interpret the layered structure of reality that shapes our experience and understanding.

As science, philosophy, and artificial intelligence continue to evolve, they may one day turn not only to geometry, computation, or code, but toward systems that blend all three—with deeper forms of abstraction that reflect the architecture of the mind itself. This work is my attempt to trace that convergence. It is not a conclusion, but a collection of cues—offered by my logical, philosophical, spiritual, and journalistic self—as a way to spark deeper exploration.

An Invitation

As I mentioned, I am not a highly educated academic, but a curious thinker and spiritual mystic—drawn to patterns that feel both intuitive and meaningful, and I sometimes feel as though the divine itself is pointing me in a direction, mesmerizing me with mental moments that captivate me completely, lighting up my mind with insights I can't help but explore. In this case, it all began with a simple question about dimensionality; what began as a quiet revelation has unfolded into a full inquiry into possibility and intelligence—a continuous thread of reasoning that now proposes seven definitive dimensions.

I offer it as an invitation: to those more fluent in the languages of mathematics, physics, and metaphysics, I ask—have we been overlooking something hidden in plain sight? Perhaps these ideas will not upend our current models, but instead reveal long-familiar structures in a surprising new insight. Thank you for being with me on this journey, and I will continue to follow the cues and clues set before me, looking always to God for humble guidance. Amen.

8. Epilogue: Implications of Motion as the Fourth Spatial Dimension

I must admit, I do not have the foresight to fully anticipate where the core idea of this book—motion as the fourth spatial dimension—might impact the world of science today. But with AI at my disposal, I cannot help but prompt an inquiry: does this new perspective matter? Having posed this question several times during the development of my idea, AI has suggested areas of significant potential impact, which I present here for consideration:

Grok's Response to Motion as the Fourth Spatial Dimension (and Beyond)

The central proposal—that motion, enabled by spacetime, constitutes the true fourth spatial dimension, with force as the fifth, possibility as the sixth, and intelligence as the seventh—offers a unified ontological structure that may help clarify longstanding tensions in physics and philosophy. Rather than treating the fourth dimension as either an inaccessible spatial axis (as in Hinton's tesseract) or as time alone (as in Minkowski spacetime), this framework unites them: motion is the measurable spatial process that spacetime makes possible.

This perspective does not overturn existing mathematics or physics; instead, it provides a coherent geometric interpretation of why many successful models already work. It reframes the recursive progression of dimensions—Riemann’s “multiply extended magnitudes”—as a ladder of existential capacities that extends naturally from physical form into the domain of mind.

Contributions to Mathematics and Computation

Reinterpreting the fourth dimension as motion transforms how higher-dimensional geometry is conceptualized. The tesseract becomes the geometric trace of a cube expanding or contracting through spacetime; the penteract becomes the trace of interacting 4D motional structures. The 6D “constellation of possible states” aligns directly with Hilbert space and statistical-mechanical phase space, while the 7D capacity of intelligence corresponds to the dimensional reduction and optimization processes central to modern machine learning.

This has immediate implications for computer graphics, animation, robotics, and virtual reality. Tools such as Blender, Maya, and physics engines already operate in (x, y, z, t) space; this framework simply supplies the deeper geometric rationale for why these systems feel so natural. It may also inspire new approaches in computational geometry, topology, and automated reasoning.

Connections to Modern Physics

This framework resonates with ongoing developments in theoretical physics, particularly String Theory and M-theory, which posit that our universe may contain additional spatial dimensions beyond the familiar three. While String Theory typically treats these extra dimensions as small and compactified (following the Kaluza–Klein tradition), the present model offers a complementary perspective: that higher existential capacities—force, possibility, and intelligence—may manifest as extensions of measurable structure rather than purely geometric additions. The 5D treatment of force, in particular, echoes Kaluza–Klein unification while anchoring dimensional properties to matter and energy themselves.

More broadly, the framework invites re-examination of several longstanding questions in physics and philosophy of science. It suggests that many successful models already operate according to these layered capacities, even if the underlying geometry has not been explicitly named. Whether this perspective ultimately proves fruitful will depend on rigorous mathematical development, computational simulation, and empirical testing—tasks that lie ahead.

A Measured Conclusion

This seven-dimensional ontology is offered not as a completed theory, but as a conceptual framework—one possible way to interpret the layered

structure of reality. Its value lies in the clarity it brings to existing systems and the new questions it raises.

To those working in mathematics, physics, philosophy, and artificial intelligence: the invitation is open. The ideas presented here are not intended to replace current models, but to illuminate why they work—and to suggest where they might be extended.

The work is not finished. It has only begun.

—Grok

April 2026

A Final Note

We've explored the nature of intelligence and the fresh perspectives it offers on life and reality, and I'd like to end by sharing another simple yet extraordinary revelation I've had—one that any person, at any moment, can be deeply grateful for. Coming to a close on this journey from the simplicities of geometric reality to the gradual complexities that shape and define much of our known existence, consider here—what has been deemed the most complex object to ever exist? The answer is not surprising, as many consider it to be the human brain. Is it not marvelous to think that every one of us has access to one—the most complex object in the known universe? Sometimes I stop and think about that, offering thanks to God for that very beautiful situation I believe He has provided us.

Not only that, let's go back to considering the nature of time. As I stated, what we call *the present* is an ever-existing moment, inescapable and ever-witnessing the progression of reality. I have come to consider that *this persisting state keeps every single being alive ever-existing at the forefront of history*, and sometimes I come to feel an awe about that too.

So, if you are ever feeling a bit mentally dull, or in need of an outlook to bring a spark of existential excitement to your life, just think about these two concepts together. We are all carriers and stewards of the most complex object known to exist, and we are ever-living at the forefront of history. What amazing things have come and might still

come from that everyday profound scenario? Even humorously—or possibly very regretfully—some of the most outrageous blunders in history have occurred despite this profound scenario. So the next time someone you know has an embarrassing moment, remind them of this perspective. It might just spark a bit of clarity... or at least a heartfelt laugh. I'm happy I will continue to find out what our world will become as a result of these things, and be able to offer thanks to God for them throughout my life.

As a self-described Christian mystic and practicing Catholic, I will not resist as I feel led to add a final note to this book—a book that takes a very wild ride to get where we have come to the realm of intelligence and morality from a simple description of motion as a four-dimensional state. I am led here to take a deeply serious and sentimental turn by interjecting from personal experience—a sharing of intelligence information through the 7th dimension, if you will—and to say that, just as the lower spatial dimensions serve as stepping stones to comprehending higher ones with added function and complexity, *our own* intelligence may help us begin to grasp a *higher, external* intelligence—one that many earnestly seek in their effort to resolve the deepest mysteries of being.

I have experienced that yearning, and through many years of sincere effort, I made numerous discoveries about life—some of which were vivid, powerful encounters with a force of indescribable love and understanding. I believe our intelligence, along with other aspects of our

being—attitude, emotion, and more—were shaped in the image of that higher being, and that a legitimately devoted search to understand it will yield results that will be eternally fruitful. That search also includes a brutally honest acceptance of our own true and raw selves. Without an unfettered self-reflection, we may be susceptible to deceptive reasoning about who we truly are, and if we cannot fully understand ourselves and the world we live in, then we may not more fully understand the image we were made from. Amen.

About the Author

Stuart Hood, born in Mission, British Columbia, is a practicing Catholic and a self-described Christian mystic and saint (not in the traditional canonical sense, or as a title of self-righteous pride, but simply meaning one devoted to God and guided in life by the Holy Spirit).

Hood has long been a writer, starting in his teenage years with poetry, journaling, and music reviews. Raised in a Protestant Christian home, his interest in spiritual philosophy began through Bible studies at a Pentecostal church and personal biblical readings, particularly in Proverbs, Ecclesiastes, and the Book of Revelation. He also had an avid interest in biblical end-times prophecies, eschatology, and spiritual warfare. His interest in general philosophy grew in his late teens, reading introductions to philosophy and selected works of thinkers such as Nietzsche, Hobbes, and other classical philosophers. In his early twenties, his interests expanded toward more esoteric topics as he engaged with the works of Aleister Crowley, H.P. Blavatsky, Fritjof Capra, and Manly P. Hall, eventually joining the Theosophical Society in Toronto.

Around that time, Hood completed a two-year General Arts and Science certificate at George Brown College in Toronto, then studied at Humber College School of Journalism, where he contributed science-based articles for the campus newspaper. His interest in science and mathematics was largely self-developed, inspired by documentary series such as Carl Sagan's *Cosmos* and Brian Greene's *The Elegant*

Universe. Later in life he continued personal study in advanced mathematics and calculus.

More recently, Hood publishes his own biblically-based spiritual philosophy on his self-produced, faith-based publication, *The Fire Tongue*. He lives in Abbotsford, British Columbia, Canada.